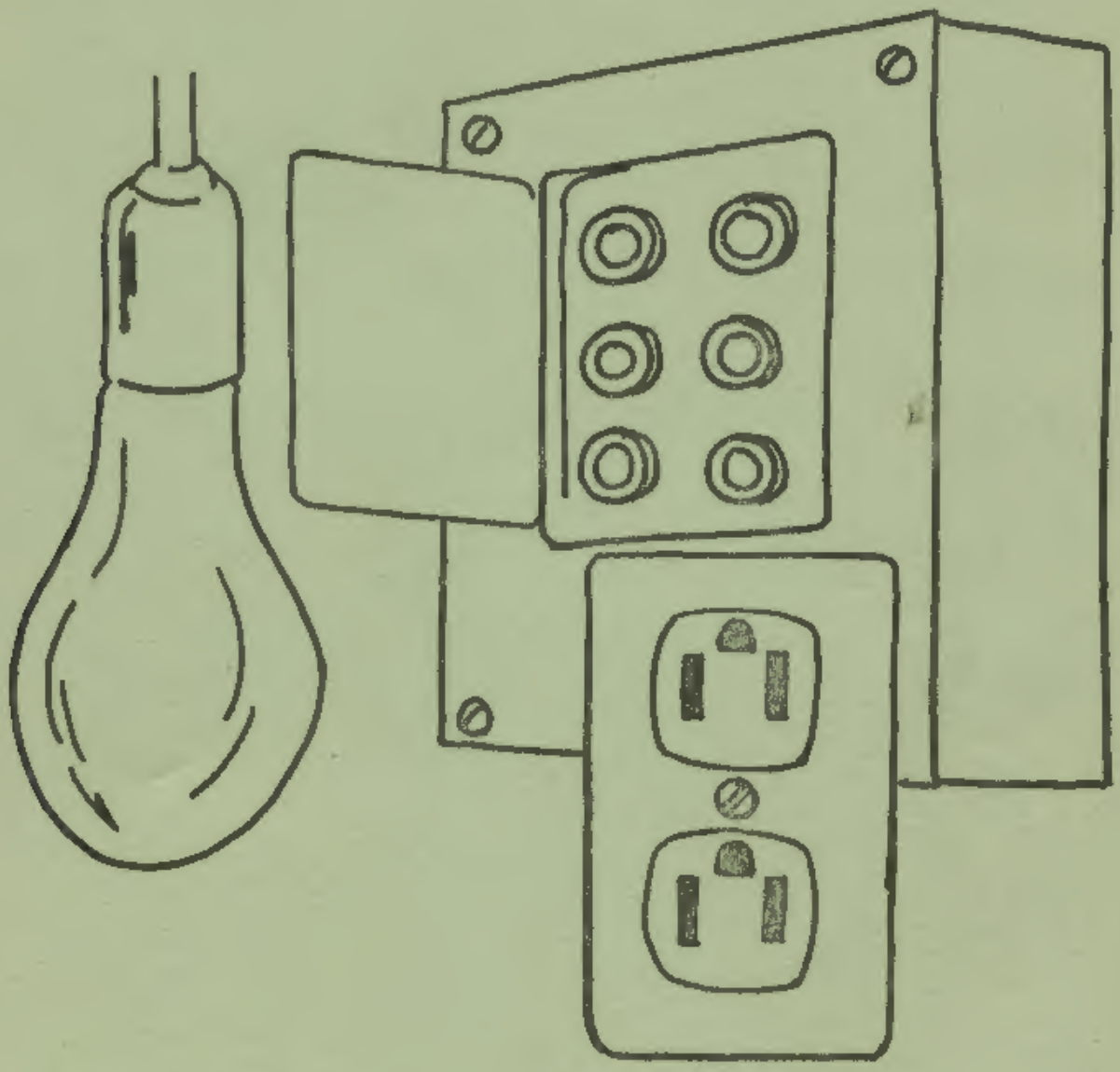
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SESSION 2

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HOMEOWNERS TRAINING COURSE

AT

NEWARK REDEVELOPMENT AND HOUSING AUTHORITY

MAINTENANCE TRAINING CENTER

4 Sheffield Drive

Newark, N.J. 07104

Saturday, December 10, 1977

9:00 a.m. - 1:00 p.m.

Instructor: Bernard Chelis

E L E C T R I C A L

Session #2 Doorbell and Chimes

1. New wiring in old construction
2. Repairs to lamps and cords
3. Fixture repairs
4. Meter readings
5. Air conditioning
6. Humidification
7. Dehumidification

Door chimes, bells, and buzzers

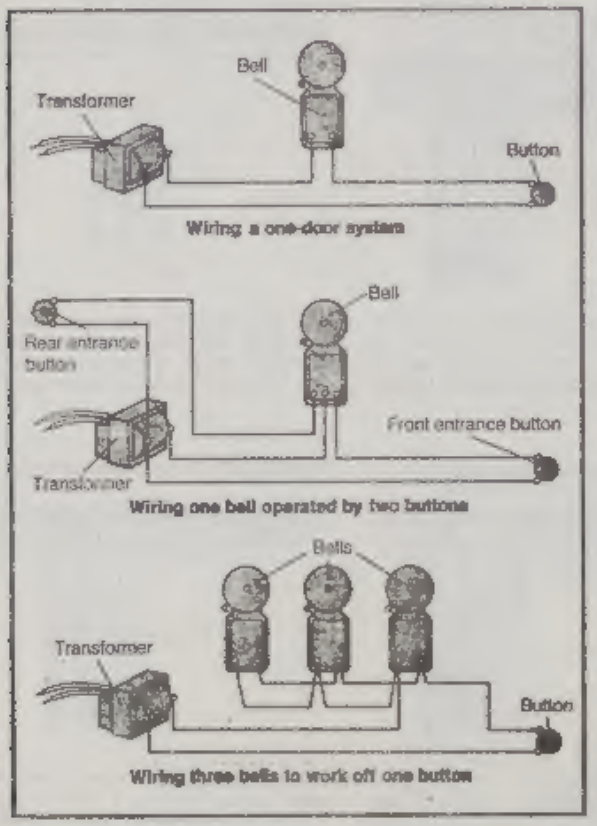
Troubleshooting and repair

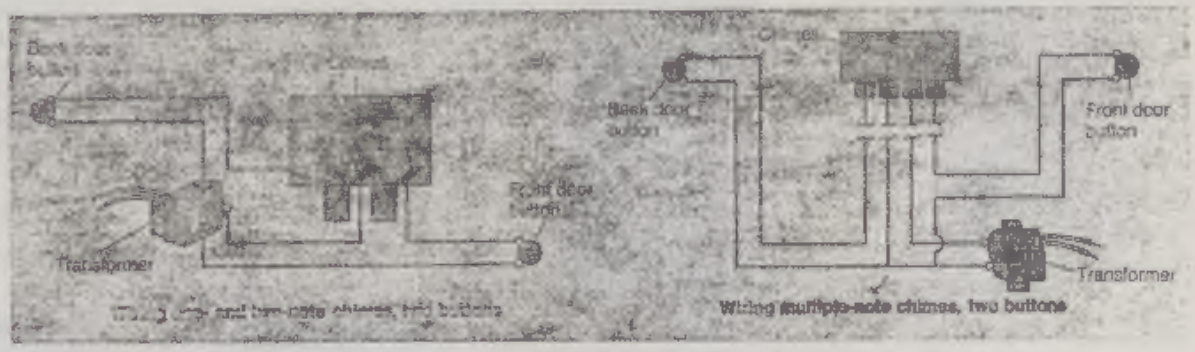
Door chimes and bells operate on low-voltage current reduced by a transformer from 120-volt household current. The reduced voltage will not give you a shock, so it is safe to work on a chime or bell system without shutting off the power.

Chime or bell failure: The first thing to check is the wiring between button and transformer. The thin wire might be broken or shorting out at some point. If so, simply rejoin or tape the wire.

If the wiring is intact, the probable cause is the entrance button. These tend to become corroded from the weather. If the contact points are accessible, clean them with sandpaper. If they are hard to get at, try replacing the button. If the button is not the problem, check connections at the chimes or bell. Vibration sometimes loosens them. The problem is not likely to be in the chime or the bell mechanism. If investigation leads you to believe it is, replacement is probably easier than repair.

Installing new chimes: Locate the transformer unit, then run wires to the chime unit and, subsequently, to the entrance button. Check whether chimes and transformer operate on the same voltage. Labels will tell you. Many transformers provide a variety of voltage levels with separate terminals marked for each. Be sure to use only those suited to your chime or bell.





Installing chimes



Install the transformer in a convenient junction box. With power off, punch out disk and insert transformer wires.



Transformer is fastened with a nut. Some transformers must be mounted outside the junction box; only the wires go in box.



Using wire nuts, fasten wires from transformer to house wiring. Black is joined to black and white to white.



Connect low-voltage bell wiring to transformer terminals. Run the wire through the house to location of chime unit.



Push-button wires may be run on outside or inside of door molding. Bore hole in molding and connect wires to button.



Connect all wires to correct terminals on chime unit. The terminals are usually marked by the manufacturer.

Wiring new circuits

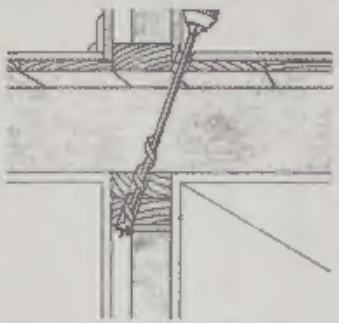
Wiring in old construction

Wiring in new construction is seldom a problem since all studs and ceiling joists are exposed and accessible. Running wires in an existing structure, however, poses the problem of working inside walls. In the case of plaster walls or ceilings, channels must be gouged out for the wires and later replastered. In such instances, surface wiring is easier.

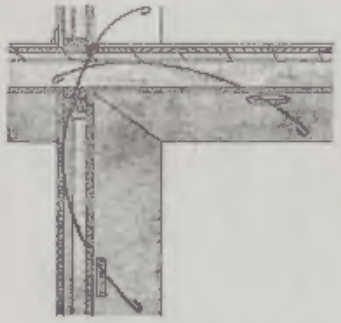
For drywall construction, it is necessary to wire through the spaces between walls and ceilings. The method of doing this is known as "fishing." This is done with a fish tape, a springy length of wire that is hooked at one end. It is fed through pre-drilled access holes in ceilings, floors, or walls. The electrical cable is attached to the hook, then pulled through the construction.

Wherever possible, plan to run wires across an attic floor or across the open ceiling of a basement. This will minimize the amount of fishing.

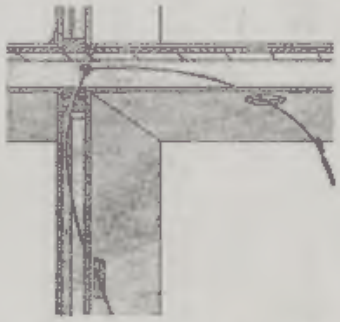
Fishing a wire



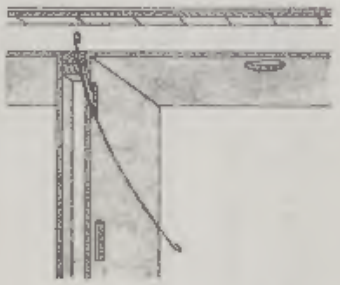
If there is a room or attic above, remove baseboard and drill diagonally through supporting beams into wall cavity. Use a brace and 18-in. bit.



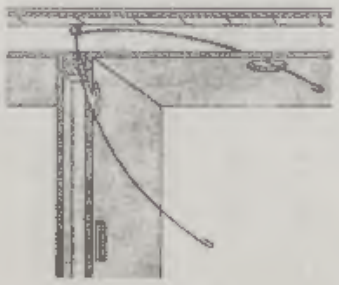
Feed a 12-ft. fish tape down from upper room and out the electrical box hole in the wall. Feed a second tape through ceiling hole. Hook the tapes.



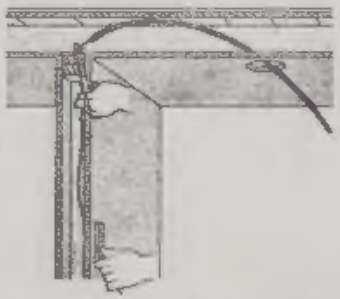
Withdraw both tapes through ceiling hole. Bind wire cable around hook, making sure no part of the binding is larger than the bored hole.



If there is no access above, cut large hole in wall 5 in. from ceiling. Bore diagonally up through support beams into ceiling cavity. Insert fish tape.

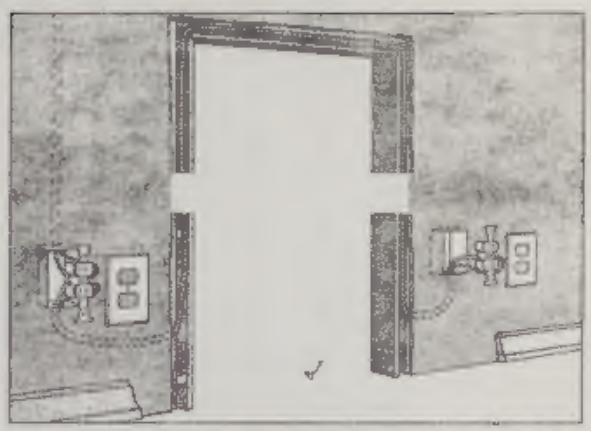


Insert second fish tape through ceiling hole. Fish until tapes interlock. Withdraw tapes through ceiling hole until hook of wall tape can be grasped.

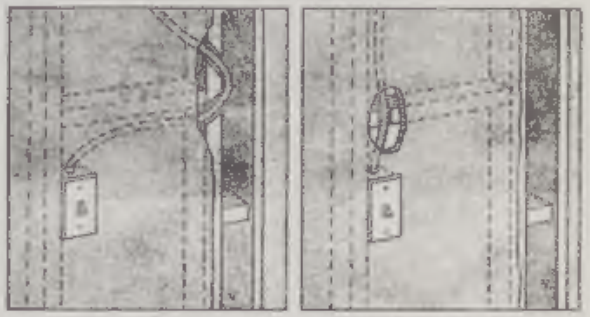


Attach cable to tape hook, then withdraw tape and cable by pulling down through large hole in the wall. Feed free end of tape out box holes.

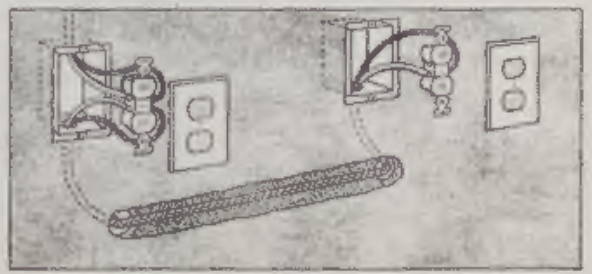
How to run a wire



Wiring around door frame: Remove baseboard and door trim. Notch wall and spacers between frame and jamb. Use an 18-in. bit in a brace to drill through headers and uprights.



Wiring around door-frame headers: Notch upright twice and wire through both notches. Or make hole in wall, notch header, pass wiring through notch in header. Replaster hole (p. 92).



Wiring from one outlet to another in plaster walls: Notch plaster so the wire can run in a channel inside the wall. Notch hole for box. Connect wires and replaster.

Cords And Safety

Don't Let a Cord Tie You into Knots. A mistreated connecting cord is often the cause of an appliance's breakdown. See that wires are well-insulated and don't abuse them.

Many common household appliances stop working unexpectedly not because of any internal breakdown but only because their connecting cords are stepped on, crushed, broken, cut, chewed by animals or otherwise mistreated. It seems rather obvious to say so, but an appliance can't operate if it doesn't receive power from the wall outlet.

Safety is strongly stressed by all elements of the electrical industry, but equipment manufacturers apparently have a blind spot when it comes to connecting cords. They produce appliances with strong, well-engineered bodies, and then, to save a few cents, they hook on flimsy cords with insulation so thin you can puncture it with a fingernail. Once installed, most appliances are not subject to physical abuse, but their loose cords often take a beating. Pay some attention to them and their life span will increase. And if you have to replace one, use heavily protected wire.

When a plug is removed from its outlet, a knot often forms in the cord because of the curl in the wire. Open it before reinserting the plug. If knotted cord is yanked, it can sever the wire within the cord.

Some floor lamps provide no protection for the wire at point of emergence. Moving the lamp just a few times when cleaning the room will cause a short circuit. A layer of tape is an effective preventive measure.

You can walk on a flexible cord only so many times before the insulation gives way. The bare wire is then both a shock and fire hazard, especially to the children. Place loose wires as near as possible to the wall.

Don't let a cord get pinched in a section of a dropleaf table; if the wire is crushed, remove wall plug before touching it because strands sticking through insulation might well be "hot." Reinforce damaged section with layer of tape of nearest matching color. For white cord, white adhesive tape from the family medicine chest is ideal. Colored "Scotch" tape is also OK.

Vacuum cleaner cords take a particular beating because the appliance has to be moved around alot. Try to keep the wire from under the wheels.

The sharp edge of a heavy pressing iron can do a lot of damage to the flexible cord. Keep the wire clear by hanging it over the back of ironing board.

Many attachment plugs are made very cheaply of fragile compositions known in the trade as "molded mud." It is little wonder that they break up when stepped on or burn up when subjected to heavy current overloads. When buying replacement plugs, look for smooth, well-formed bodies, securely

fastened prongs, terminal screws with broad heads, and fiber protection washers to fit over prongs and terminals, for your protection.

Never attempt to salvage a damaged plug by fastening the pieces together with tape or string. If the connecting cord is still in good condition, cut it off close to the plug, and discard the pieces of the latter. Use diagonal cutters, as above, or heavier "electrician's pliers." Examine wire carefully and trim off any sections near the end that show signs of crushing or bruising; these can be dangerous when you use the plug in the future.

In preparing old cord for new attachment plug, first separate the ends a distance of about an inch and a half. Some cords require a sharp knife for this job; others in common use can be "zipped" apart without tools. Be especially careful not to damage insulation covering on each one of the individual wires.

Using the sharp edge of knife, pare off insulation on each end of wire a distance of about a half inch. The next step in attaching a new plug is to twist together the loose strands at end of wires. With back edge of knife, scrape end of wires clean and bright. Don't touch with fingers after this. Apply thin coat of solder to each wire. This stiffens wires and makes them easier to fasten under the plug.

Immediately after soldering the loose end strands of the wire, poke the cord through the attachment plug.

Starting from the pared ends of the wires, apply a layer of strong electrical tape back along the cord a distance equal to the length of the plug plus about a half inch. This tape will reinforce the insulation.

The wires are much easier to connect under the terminal screws of the attachment plug if they are first formed into U-shaped loops. Use long-nosed pliers to close the loops under screws and tighten.

When securing the wires under the terminal screws, make certain that no loose strands stick out. These are often the cause of over-heating at the plug or of blownout fuses. If appliance is of portable type and plug is inserted and removed frequently, make periodic examination of terminals and tighten again if necessary.

Re-cording A Lamp

The extent of the damage to your present cord will determine whether or not it needs replacement; with luck all you may need to repair it is a piece of electrician's tape.

The flexible cords of table and floor lamps usually show the first signs of wear at the point where they emerge from the base. If there is any leeway in the wire, sometimes it can be pushed into or pulled out of its hole, taped over, and then put back into place. If the rest of the cord is also damaged in any way, it's better sense in most cases to take out the old cord and put in a completely new one.

Remove the shade for safekeeping; it's usually held in place with a decorative nut or stud, which unscrews readily. Following this, obviously, the bulb is removed and then actual repair work begins.

Next, snip off the old wire at the base of the lamp. Save good sections for other uses. To disassemble socket look for word "press" on shell near switch. Insert blade of small screwdriver, twist slightly, then press end of socket downward. This opens the toothed joint between the halves of lamp socket.

Next, remove old section of wire, inspect and clean socket, and tighten small screws inside shell as needed.

Next, check fit of socket and shade holder on neck of lamp; twist to right to tighten. Then, feed the length of

the new wire through the fixed part of the socket, down through base of the lamp. Separate ends of new wire, remove insulation, scrape clean and tighten wires under two screws of the socket shell. Then from the bottom pull wire down carefully till socket is in position. Now snap other section of socket back into position; start it at a slight angle and then squeeze along the bottom. Finally, protect new wire where it passes through base with ordinary white adhesive tape.

Extension Cords, Selection & Use

When a lamp, power tool or portable household appliance must be used at some distance from the nearest electrical outlet, a flexible extension cord is usually used to extend the reach of the existing cord. If the wrong kind of cord is used - or if the right kind of cord is improperly used - a potential hazard is created.

Extension cords not only vary according to length and capacity (capacity is determined by the size wire they contain), they may also vary as to the conveniences they offer and the jobs which they will perform. Basically speaking, all cords are flexible connectors which contain two or three rubber-coated conduction wires. To make them fully flexible, the conductor wires usually consist of a series of fine strands of wire twisted together, rather than of solid metal.

Practically all of the homeowner's extension cord needs will be filled by one of three general types of cord: a heavy-duty rubber-coated cord (often referred to as type S) which is used for outdoor work or wherever heavy wear is expected; a thin, flat, rubber-coated lamp cord (usually call rip cord) which is used for small appliances and lamps and the special heating unit cords which usually have an asbestos covering.

To make certain that an extension cord has been approved for dependability and safety, the homeowner should look for the Underwriters' Laboratories inspection tag (UL) on all parts - that is, on plug, connector and cord. In addition, there is a special flag label which bears the initals S.E.C.C. This indicates that the entire cord set as assembled has been inspected and approved by the Safe Electrical Cord Committee.

Just as adequate wiring is required in household branch circuits to avoid overloading these circuits and to prevent burning out of fuses, so too is it essential that the homeowner remember to use an extension cord which is adequate for the power load it must carry. This is particularly true of extension cords which have double or triple outlets at one end.

Remember that if several appliances or lights are plugged in at one time, and all are in use simultaneously, there is a good chance that the cord is being overloaded. This not only creates a fire hazard, but can cause breakdown of motor-driven appliances. The voltage drop which occurs can prevent the motor from getting sufficient power to operate properly.

Two factors affect the carrying capacity of any extension cord: the size wire it contains and the length of the cord. Ordinary light-duty lamp cord usually contains #18 wire, and it should never be used to carry power to heavy-duty power tools or appliances which draw more than 7 amperes. The

[illegible] studying the name plate which is attached to the appliance or tool.

If the ampere load is not indicated, remember that volts multiplied by amperes equal watts. Therefore, if the wattage is known, the ampere load can be determined. Simply divide by 110 (the household voltage). For example, a 750-watt appliance will be drawing just under 7 amperes.

Since long lengths of cord cause current-carrying capacity to drop, 16-gauge lamp cord will carry its full load of 7 amperes only for distances up to about 25 feet. If a longer cord is necessary, the wire must be thicker, reading that at least #14 or #12 wire should be used. As a general rule, most experts recommend that #18 wire be used only for lamps and very small appliances, and then only for distances up to about 25 feet.

Heavier-duty (#16 or #14) wire should be used for rotor-driven tools, electric hedge trimmers, shop motors and similar appliances. When cords 50 to 100 feet in length are required for powering tools around the outside of the house, make certain they are made of heavy-duty, 14-gauge wire. This will permit powering tools which draw up to 7 or 8 amperes (about 1/2 horsepower) without danger of overloading or of causing a damaging drop in voltage.

In addition to selecting the right type of approved cord for the job on hand, here are a number of other safety rules

that should be observed whenever electrical extension cords are used:

(1) Never run cords over radiators, pipes or other ground metal. If heat or abrasion causes insulation to dry out and crack, a dangerous short circuit can occur.

(2) Never allow cords to run under or over a door or under rugs. Continual opening and closing of the door or frequent stepping on the cord can cause damage to the insulation, often where it cannot easily be seen.

(3) Never yank a plug out of its socket by pulling on the cord. Instead, reach down and grasp the plug itself to remove it.

(4) Do not plug extension cords into a lamp socket. Always plug the extension directly into a convenient wall outlet. Lamp cords and sockets are not designed to carry much of a load.

(5) Repair or replace cords promptly when insulation becomes frayed or cracked. Also get into the habit of inspecting the cord carefully at frequent intervals to check for defects.

(6) Never use flexible extension cords to create additional "permanent" outlets by tacking or stapling them in place. This practice is extremely hazardous since insulation is easily damaged or cracked so that short circuits can occur.

When permanent extensions are required, use one of the new types of surface extension wiring instead. These contain heavy-duty, plastic-covered cables, receptacles, switches and

other fixtures which are specifically designed for permanent mounting along walls or overhead.

Extension cords

Household extension cords usually have only two wires inside and are adequate only for the operation of one or two small appliances. The thinner the cord, the lower its capacity for conducting electricity. Too many appliances or lamps plugged into the same cord will cause it to overheat, creating a possible fire hazard.

Length is also important. A longer cord wastes current. If it is too long, the drop in current can reduce an appliance's efficiency. The table below recommends suitable extension cord wire lengths and diameters for various electrical loads.

Remove extension cords from an outlet by grasping the plug body. Otherwise, the wires may tear loose, resulting in a shock or short circuit.

Three-wire extension cords are used for electric power tools and outdoor appliances. The third wire is a grounding wire; plug this type of cord into a grounded outlet or ground it with a suitable adapter plug. Use only 3-wire extensions for tools and appliances that have 3-wire cords.

Most cords are sheathed in plastic that can take rugged use. Rubber-sheathed cords are more flexible and easier to store.

Selecting the proper length

Length	To 7 amp.	7-10 amp.	10-15 amp.
To 25 ft.	No. 18	No. 16	No. 14
To 50 ft.	No. 16	No. 14	No. 12
To 100 ft.	No. 14	No. 12	No. 10

Wire diameters are based on AWG gauge.

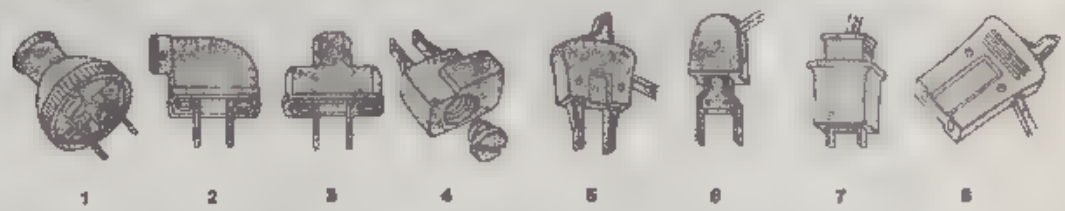
Splicing cord wires



1. Cut away damaged insulation with scissors. Cut both wires in half with wire cutters. Strip 1 in. of insulation from wires with wire stripper or sharp knife. **2.** Twist ends of both wires. **3.** Wrap each wire with tape, then wrap wires together. Overlap tape onto cord. Splicing is an emergency repair not approved by electrical code. **Do not splice house wiring.**

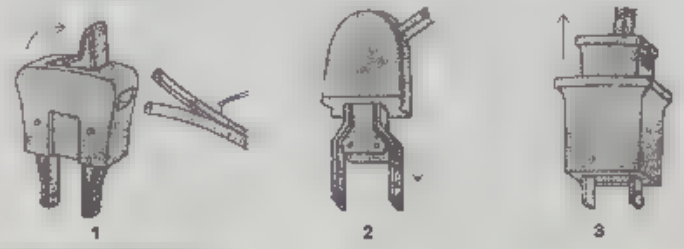
Replacing damaged plugs

Types of plugs



Plug replacement is easy with these readily available plugs. In addition to the new plug you'll need wire cutters, a screwdriver with a small tip, and a sharp paring knife. Replacement of round-wire plugs (Nos. **1–3**) and flat-wire plugs (Nos. **5–8**) is illustrated below. For plug No. 4, loosen screw, slip wire into casing, and tighten screw.

Flat-wire plugs



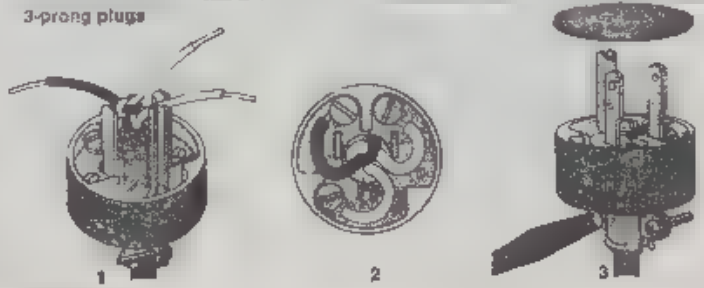
1. Lift top clamp. Slit cord ¼ in. between wires. Push cord into plug. Loosen clamp. **2.** Grasp prongs and pull away to remove from casing. Spread prongs and wires through opening in base. Loosen screws to free prongs and wires from casing. **3.** Remove casing. Reverse wires and push through plug. Replace casing. **Flat wire plugs are easiest to replace because no wire stripping is involved.**

Round-wire plugs



1. Loop both wires exactly as shown to tie an underwriter's knot. Push the knot down into the plug casing between the prongs. This knot is important because it prevents the wires from pulling out and the plug from being pulled from a socket by the cord. **2.** Strip ½ in. of sheathing from each wire. Twist wires in clockwise direction. **3.** Loop wires around screws in clockwise direction. Tighten screws and clip off any excess wire. Be sure that no strands come in contact with those of the white wire.

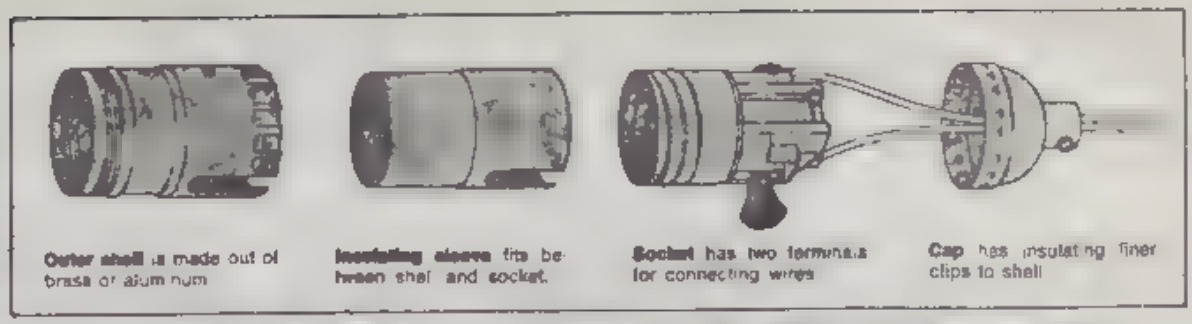
3-prong plugs



1. Loop all three wires together if plug space permits. If space does not permit, tie black and white wires in underwriter's knot as above and leave green wire free. **2.** Strip ½ in. of insulating sheathing from all three wires. Twist wire strands clockwise and wrap wires clockwise around screws. Wrap green wire around ground screw. Tighten screws. Clip off excess wire. **3.** Slip on protective cover. Various plugs and push down to cover exposed wires. This is an important safety precaution.

Probable sources of trouble

If a lamp flickers or will not go on, check to be sure that the bulb is still sound and tightly seated, and that the plug is firmly in its outlet and the socket is functioning. If none of the above is causing the problem, unplug the lamp and check the cord for fraying, cracks, bare wires, or loose connections at the plug. If the cord is damaged follow the instructions below to replace it. If the cord is not the problem the difficulty may be in the switch. If it is necessary to install a new switch, examine the old one closely before disconnecting the wires, then connect the new switch in the same way



Outer shell is made out of brass or aluminum

Insulating sleeve fits between shell and socket.

Socket has two terminals for connecting wires

Cap has insulating liner clips to shell



Repair procedure. First disconnect the lamp from the wall outlet. Use a knife to pry off the protective fiber to give access to the wiring in the base of the lamp.



Use a wrench, or pliers, to remove the nut that secures the long, threaded tube to the base of the lamp. Most lamps will have a washer that will remove this from the base as well.



Pull the [illegible] from the [illegible] lamp. Unscrew the socket from the [illegible] ing. [illegible] If you are renewing a cord [illegible]



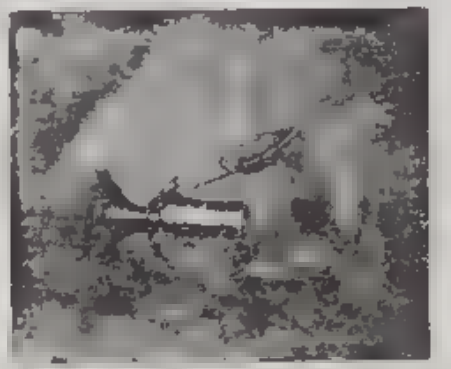
Remove the [illegible] socket by pressing at the base and pulling it straight up. Slide off the cardboard insulating [illegible] sleeve. Unscrew the [illegible]



Unscrew the two wires on the terminals. If you are replacing the switch or socket, fit the wires onto the new unit in the same way as they were attached to the old one



If fitting a new wire and plug, [illegible] wire through the lamp base and threaded tube. Connect wires to switch [illegible] socket. Reassemble lamp in same order that it was dismantled



Some [illegible] have [illegible] which must be removed before further dismantling. Remove by pressing the two bottom arms together. Some types are held by finger nuts

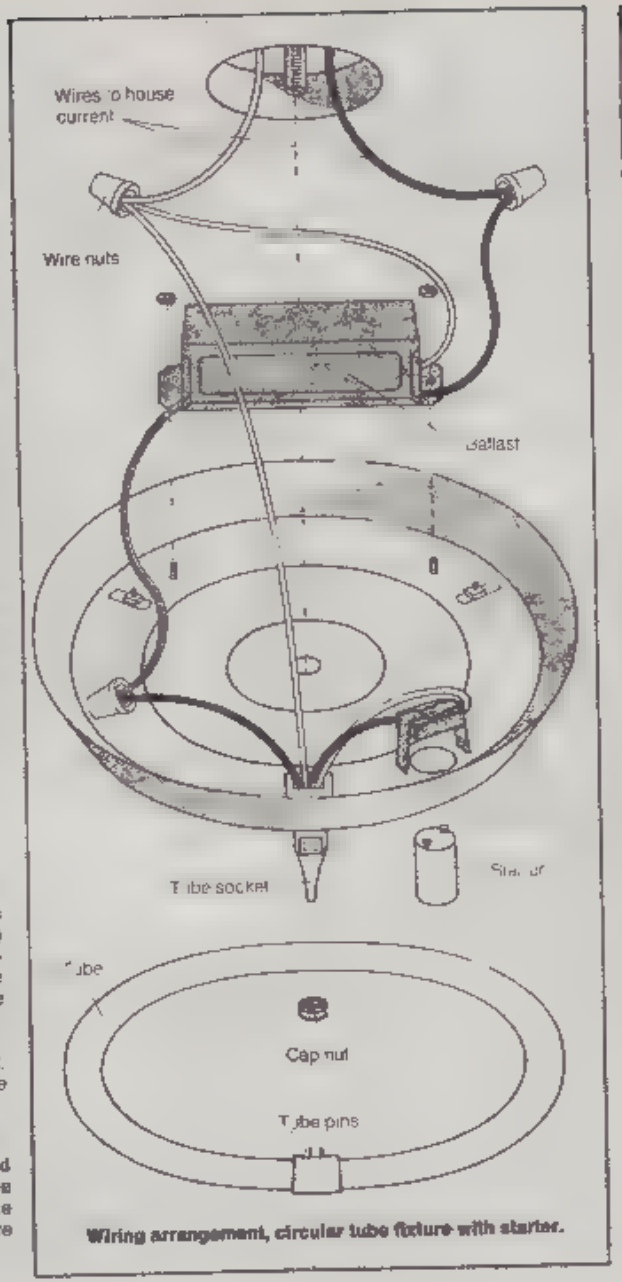


Some sockets and switches have metal shells which are removed by pressing at their base. Use same procedure as above for switch or socket replacement in this type of fixture

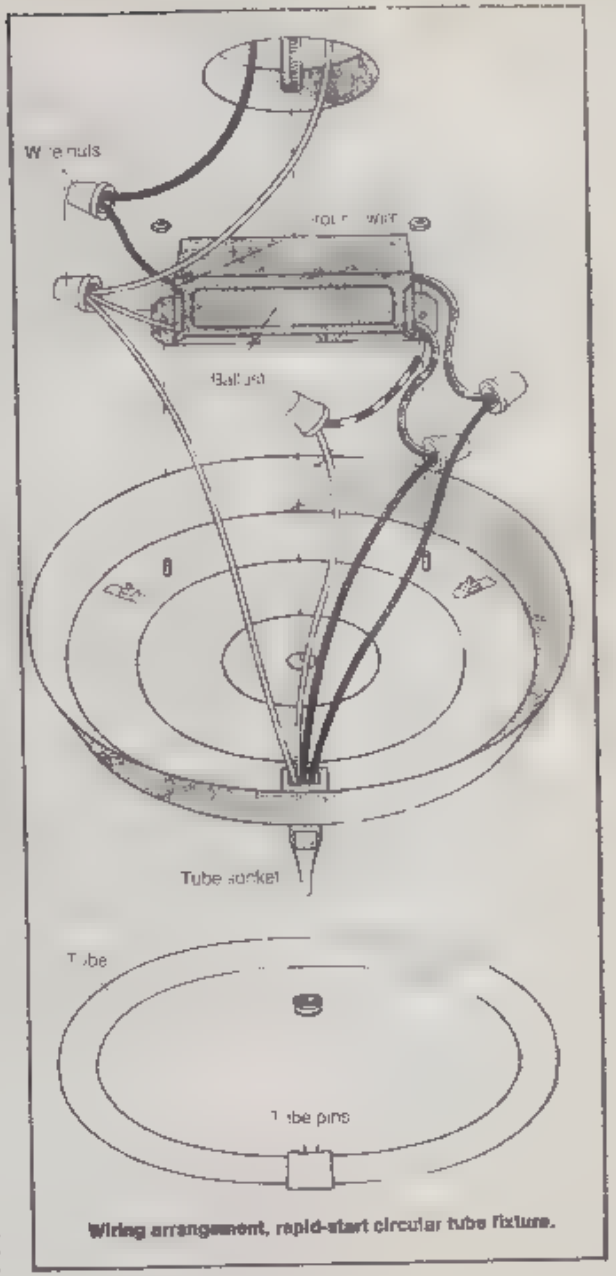
Troubleshooting checklist

Before making repairs, be sure power is off.

Problem	Solution
Tube will not light	**(1)** Make sure that **fuse or circuit breaker** is not blown or tripped (p. 252) **(2)** If fuse or circuit breaker is intact, try replacing the **starter. (3)** If this does not work, renew the tube. **(4)** As a last resort, replace the **ballast.**
Light flickers and swirls around inside tube	**(1)** If tube is new, this condition will disappear with use. **(2)** If tube has been in operation for some time, replace the **starter. (3)** If replacing the starter does not correct the condition, replace the **ballast.**
Light blinks on and off	**(1)** Tube is probably not properly seated in its socket **(2)** Remove the tube and examine the pins on the end. If pins are bent, straighten them with long nose pliers. Reinstall the tube in its socket **(3)** If it still blinks, remove it again and lightly sand the **pins. (4)** Turn off power to fixture. Straighten socket contacts with long nose pliers. Sand socket **contacts.** Brush out residue with a toothbrush **(5)** Remove tube and fixture cover. Tighten any **loose connections.** Reinstall tube **(6)** Replace **starter (7)** Replace **ballast (8)** If fixture is in area of low temperature, replace **tube** with jacketed all-weather tube **(9)** Replace **starter** with low temperature starter **(10)** Replace **ballast** with low-temperature ballast **(11)** Replace entire **fixture** with low temperature type
Fixture hums but otherwise works properly	**(1)** Make sure ballast **connections** are not loose **(2)** Replace present ballast with special low-noise ballast
Ends of tube are discolored	**(1)** A brown color is normal **(2)** If color is black and tube is new, replace the **starter. (3)** If tube is old, replace it. **(4)** Make sure **ballast** is correct and that its connections are secure. **(5)** If **tube** is discolored on only one side, remove tube from fixture and reinstall. **(6)** If tube is new and one end darkens before the other, reverse the tube in its socket. and for end **(7)** Check **power** (see "Tube will not light" above) Replace tube
Tube burns out too fast	**(1)** Tube has probably been turned on and off too often. Replace **tube.** Leave new tube on for longer periods of time **(2)** Replace **starter. (3)** Replace **ballast. (4)** Make sure connections are secure.



Wiring arrangement, circular tube fixture with starter.



Wiring arrangement, rapid-start circular tube fixture.

Fluorescent fixtures

Starter-type and rapid-start

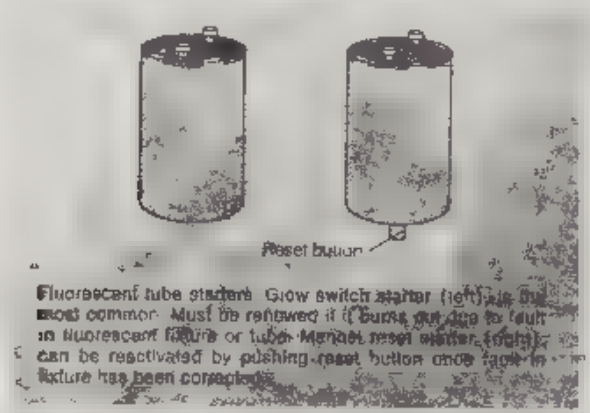
Fluorescent tubes need special fixtures to operate properly. Straight-tube fixtures contain a socket at either end into which their pins fit. The pins of a circular tube plug into a socket and are held in place by spring clips. All fluorescent fixtures contain a ballast for each tube the fixture accommodates. Fixtures for most tube types contain **starters.** Rapid-start tubes, however, do not use them.

The ground wire on rapid-start fluorescent fixtures, whether the straight or circular type, should be connected either to a ground wire in the fixture or to a grounded ceiling mounting assembly.

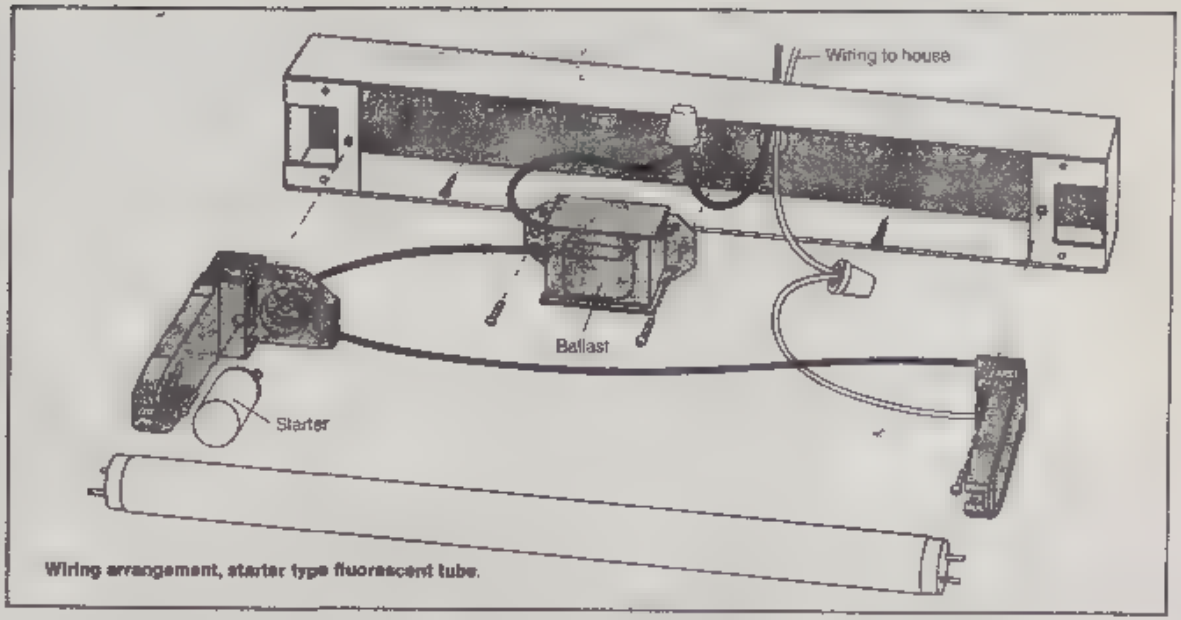
To install a starter, push it into the socket, press it down, then give it a half turn to secure it. Install a straight tube by aligning the pins with the socket slots on either end of the fixture, then push the tube in and secure it with a quarter turn.

Replacement tubes, starters, and ballasts must be of exactly the same type and rating as those being replaced. Adapters are needed to operate fluorescent tubes with direct current. Fluorescents are designed to operate in areas with a temperature of 50 degrees or higher. To operate a tube in a colder area, you need a special fixture. Turn off all power to a fixture before working on it.

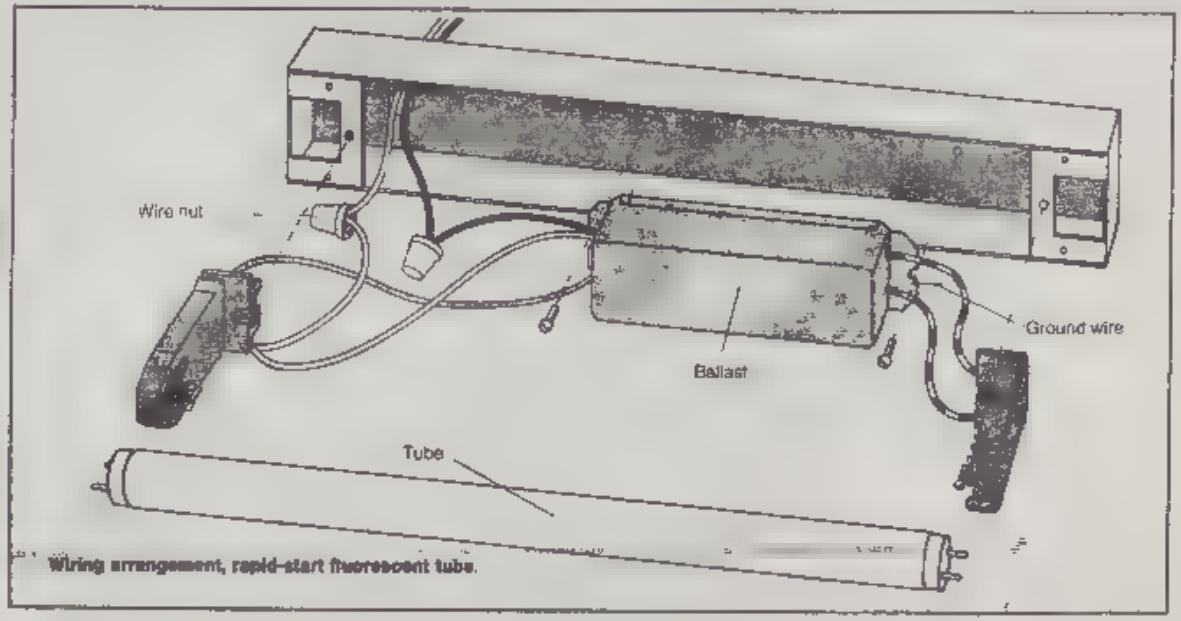
Fluorescent tubes will last much longer if they are kept burning than if they are constantly turned on and off. In fact, manufacturers rate the life of these tubes by the number of starts they are subject to. The life of a 40-watt fluorescent tube turned on for 3 hours at a time, is about 12,000 hours.



Fluorescent tube starters. Glow switch starter (left) is the most common. Must be replaced if it burns out due to fault in fluorescent fixture or tube. Manual reset starter (right) can be reactivated by pushing reset button once tube in fixture has been corrected.



Wiring arrangement, starter type fluorescent tube.



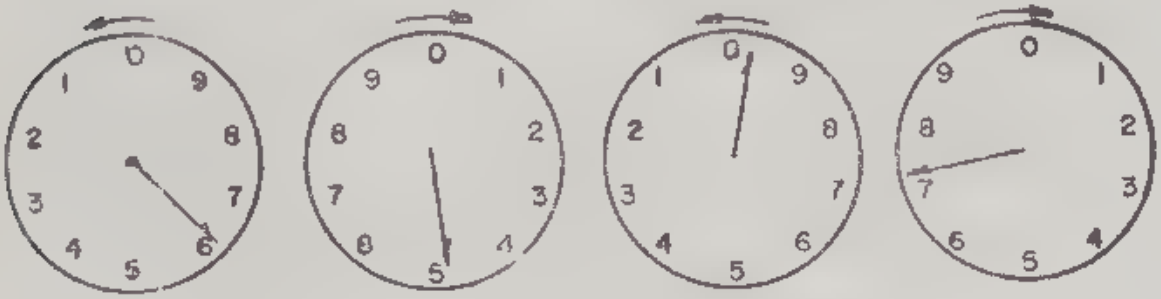
Wiring arrangement, rapid-start fluorescent tube.

ELECTRIC METER READING:

Meters for recording consumption of either gas or electricity have two or more dials on the face of meter box, depending on size. Accurate readings from the dials are important for calculating consumption over a given period of time.

EXAMPLE:

The following diagram illustrates a meter face with four dials. Arrows on diagram indicate direction in which pointers move on dials some clockwise (to right) and some pointers counter-clockwise (to left) depending on the sequence of numbers.



INSTRUCTIONS:

Reading from left to right the correct reading for the dials on the diagram is 6497.

In reading each dial, read the number which the pointer has passed. Notice the first dial above on the left, with the pointer between 6 and 7. It has passed 6 and has not yet reached 7. Record 6.

If a pointer appears to be on a number - as it is on 5 in the second dial in diagram - glance at dial to the right to see if this pointer has passed 0. In this case pointer in the third dial has not yet passed 0, therefore the reading for second dial is 4 not 5.

The third dial is recorded 9 as pointer has passed 9 and not reached 0, and the fourth dial is recorded 7.

RECORDS:

Meter reading cards shall be prepared in advance by the Superintendent, giving location and number of each meter on a separate card. As each meter is read by maintenance employee assigned, it is recorded on appropriate card following the date of reading. Particular care shall be taken to check number on meter with number on the card to be sure that the correct meter reading is being recorded.

FIGURING THE ELECTRIC BILL:

The power company usually reads the meter once each month. From t[illegible] present month's reading is subtracted the reading of the previo[illegible] nth. The dif[illegible]ence is the number of kilowatt hours used, and this, when multiplied by the rate per kilowatt hour, gives the amount of the bill.

EXAMPLE:

Present Reading (Mar. 11).....	3094 kw. hrs.
Previous Reading (Feb. 11).....	3004 kw. hrs.
Energy used during month.....	90 kw. hrs.

ALTERNATING CURRENT:

This is generally known as 60 cycle A.C. current and is a form of electricity where we have no voltage at 1/120 of a second and the next 1/120 of a second we have a voltage. This voltage and no voltage variation happens 120 times in one second, making a total of 240 changes, one cycle being equal to 2 no-voltage changes.

Alternating current is so called because it changes direction in each cycle. Most common in this area is 60 cycles. This means that in one minute the current is moving back and forth 60 times. This is determined by the speed of the generator. There are times when you can see a lamp flickering on and off, that is because the power house has put on the line a generator that has not yet reached its speed for 60 cycles.

Each of these voltages gives us a polarity of negative or positive on the line, in other words in 1/2 cycle of 1/240 of a second the line has a positive polarity, and the next 1/240 of a second we have no voltage.

DIRECT CURRENT:

This is a steady uninterrupted source of energy and has a positive and negative polarity. It is a current flowing in one direction and free from pulsations or alternations.

WIRE GAUGE:

The diameter of copper wire, most commonly used are sizes #14, #12, & #10. The size of the wire depends upon the amperage to be drawn. A number 14 wire will safely carry 15 amperes. A number 12 wire will carry 20 amperes. A number 10 wire will carry 30 amperes, etc.

WIRING:

Copper wire is used in the wiring of electrical devices, the smaller the wire the smaller the current carrying capacity, and the larger the gauge number. On larger size wire the current carrying capacity is greater and the number of the wire is smaller.

The following table shows at what size wire should be fused:

41. REPLACE DEFECTIVE SWITCH

Light switches are subject to more wear than most electrical items and in time become worn. Usual symptoms of wear are switch unusually stiff or loose; switch must be flipped several times before lights go on; lights don't work with switch on. You can select one of three types of switches for replacement unit.

Toggle switch. This is standard switch. Least expensive, very reliable.

Mercury switch. Silent in operation. More expensive than toggle switch, but lasts longer.

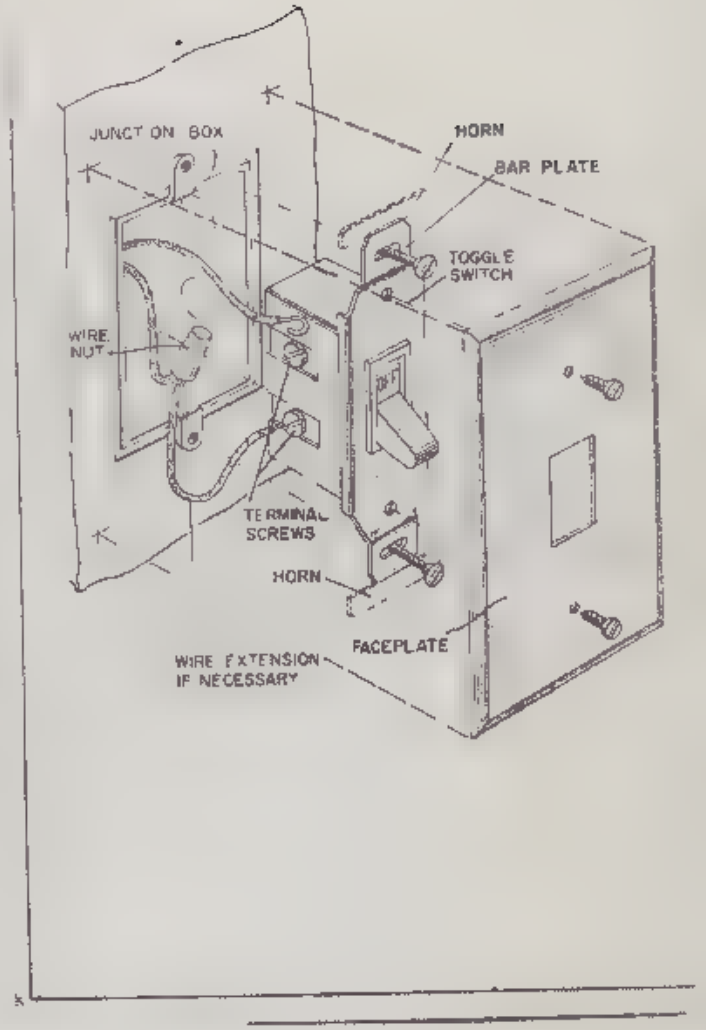
Dimmer switch. One type has HIGH-LOW-OFF positions; other has rheostat so lights can be adjusted to any brightness. Can be power savers. Good in dining rooms for "candlelight" dinners and in child's room, where low setting serves as night light.

TOOLS AND MATERIALS

Screwdriver	*Long-nosed pliers*
Wire stripper	*New switch*

APPROXIMATE TIME: 15 MINUTES

1. Turn off power in circuit at main fuse box.
2. If wall is painted, use penknife to make deep score around wall plate to cut old paint.
4. Use screwdriver to lift faceplate if it is stuck in position. Pry up from edges.
5. With switch exposed, use voltage tester (see Project 40), to be sure power is off. Touch probes simultaneously to brass and silver terminal screws. If lamp glows, current is on. *Turn it off before proceeding.*
6. Remove two screws in bar plate and pull switch out of box.
7. Loosen or remove terminal screws and disconnect wires. Remove switch.
8. Clean dust and debris from junction box.
9. See Project 42 for installation procedure.



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42 REPLACE DEFECTIVE SWITCH

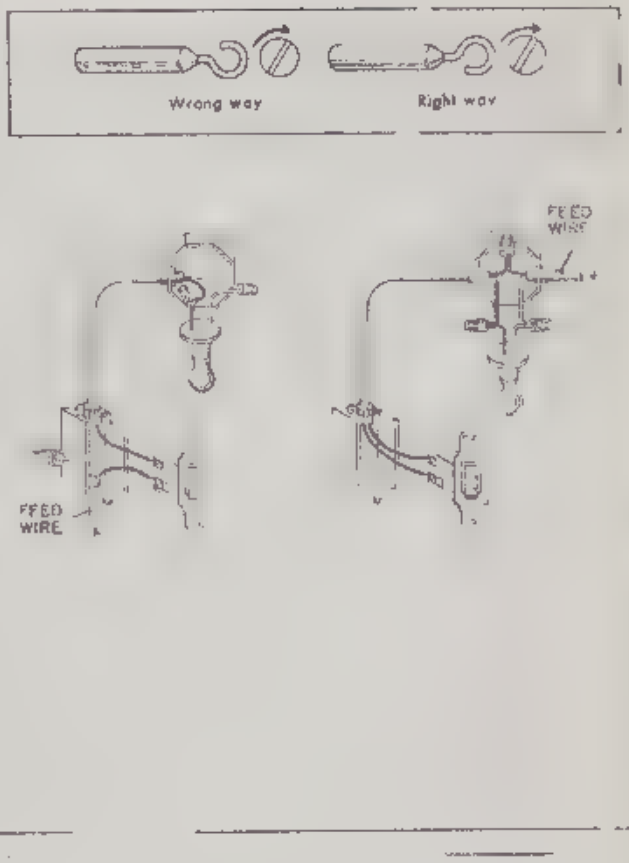
(continued)

Note that this project deals with replacement of a wall switch which controls a single light fixture with no other switch involved. If you need to replace a three-way switch—where two switches control a single light—the procedure is somewhat different. Refer to Project 44. The typical three-way switch installation is that in a stairwell when there is a switch at the top of the stairs and another at the bottom, both controlling the same light.

Continuation of steps from Project 41:

10. Loosen terminal screws on new switch. The screws on most switches cannot be removed, but only loosened.
11. If wire in the receptacle box are already formed into hooks, connect them to the terminal screws on the switch. Both terminal screws may be on same side of new switch, or they may be on opposite sides. Location makes no difference. You may have to bend hooks on wires open, using long-nosed pliers to get them on terminals. Then use pliers to pinch hooks closed after they are positioned around screw.
12. Note that hook must be positioned so that you turn screwdriver *toward* open side of hook. See illustration.
13. If wires are too short, extend them by adding short piece of wire of *same size* (probably No. 14 or No. 12). Use solderless connector as shown. See Project 35 for use of solderless connectors.
14. Tighten terminal screws and push switch back into receptacle box. You may have to bend wires behind switch with your fingers.
15. Reinstall screws through barplate. Be sure switch is in vertical position.
16. Replace faceplate, and insert and tighten faceplate screws.





44. REPLACE DEFECTIVE 3-WAY SWITCH

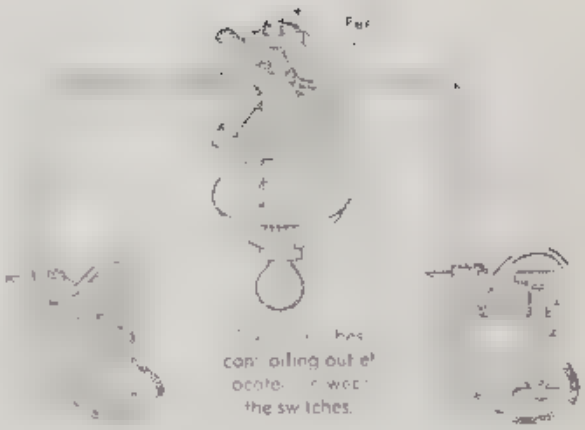
The replacement of three-way switches is the same as the replacement of a common toggle switch (see Projects 41, 4 [illegible] contact. Fasten [illegible] the terminals on the new switch to which each of the wires will go.

TOOLS AND MATERIALS

Long-nosed pliers — *Voltage tester*
Screwdriver — *New switch*

APPROXIMATE TIME: 20 MINUTES

1. Turn [illegible] breaker in main fuse box [illegible].
2. Remove faceplate by removing two screws.
3. Touch voltage tester probes to brass and silver terminal screws. If neon lamp lights, *the power is not off.* Do not proceed until power is off. You may have shut off wrong fuse or breaker.
4. With power off, remove screws from barplate and pull switch from box.
5. Remove wire from brass colored terminal of old switch and attach it to brass colored terminal of new switch. If wires are too short to permit this, use bit of adhesive tape to tag wire. Mark
6. Repeat above for wire on silver terminal. Tab it S.
7. Repeat for third wire, probably colored red. No tab is necessary.
8. Now connect wire tabbed B to brass terminal on new switch; connect wire tabbed S to silver terminal; connect third wire to the remaining silver terminal.
9. Push switch back into box. Reinstall screws through switch "ears" to barplate, making sure switch is vertical. Replace faceplate.



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45. REPLACE WALL OUTLET

Recent changes in the National Electrical Code require that whenever you replace a wall outlet you install a three-pronged

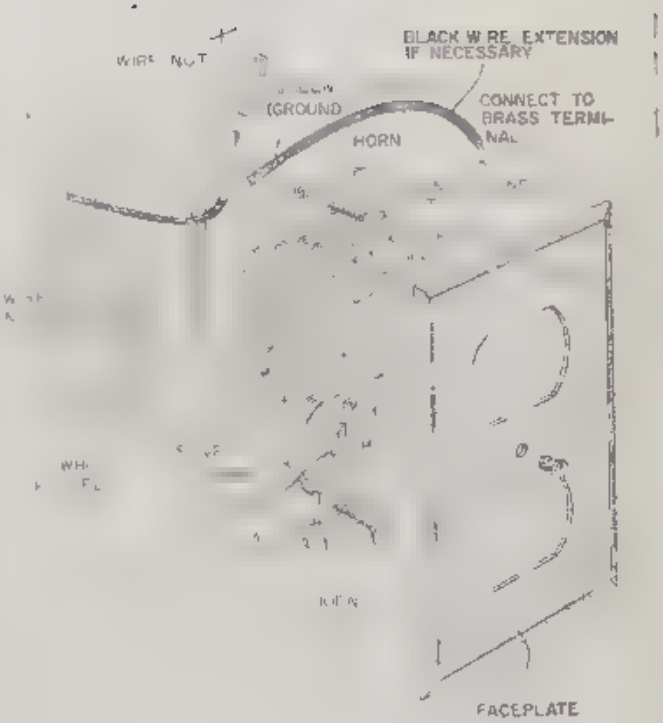
appliance.

TOOLS AND MATERIALS

Wire stripper
Screwdriver
Voltage tester
Grounded wall outlet
Long-nosed pliers

APPROXIMATE TIME 25 MINUTES

1. Turn off power at main fuse box by tripping circuit breaker in this circuit to OFF or by unscrewing the circuit's fuse.
2. Insert probes of voltage tester into power slots of outlet. If neon lamp glows, **power is not off**. Check to see if you turned off wrong circuit.
3. Remove faceplate by removing screw in center of it.
4. Cut around edge of faceplate with sharp knife if wall has been painted. Use screwdriver blade to pry off faceplate.
5. Remove screws in barplate which hold outlet in receptacle box and pull outlet from box.
6. Examine wiring. Black "source" wire connects to brass terminal and white "neutral" wire connects to silver terminal. If you see two black and two white wires, one set comes from source and second set runs from this outlet to next one in circuit.
7. If wires in wall are in conduit, ground is made through metal of conduit. If wires are in armored cable (BX), ground is through wire in cable. In both cases, no separate ground wire is visible. If system uses plastic-shielded wire, ground is made through bare copper third wire in cable. This wire is connected to grounded terminal on outlet.
8. See Project 46 for installation procedure.



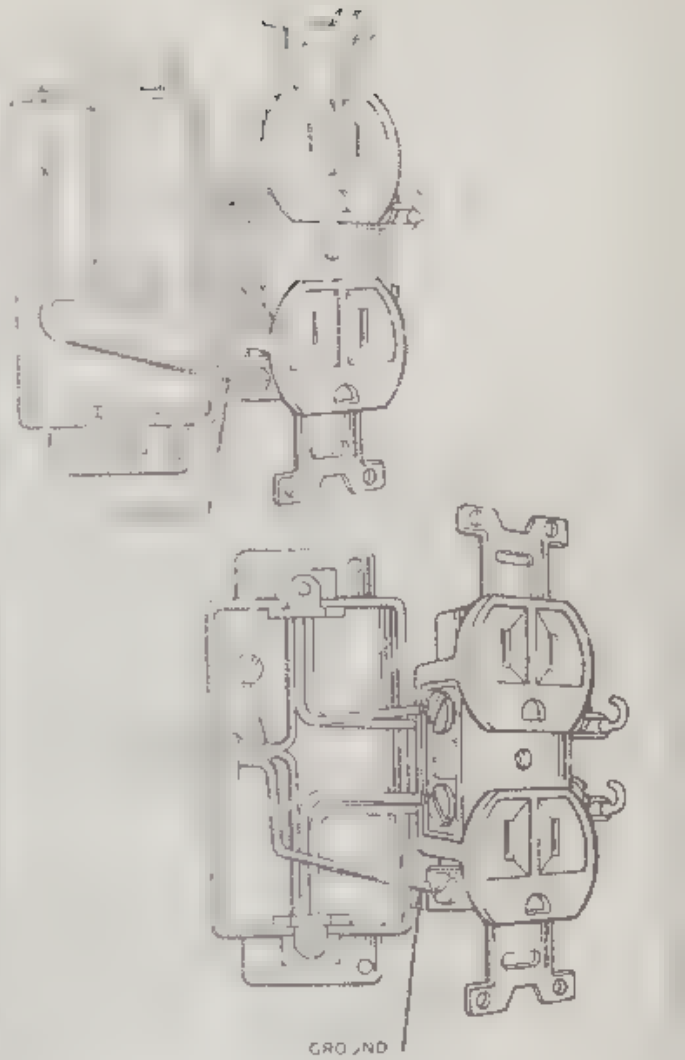
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46. REPLACE WALL OUTLET
(Continued)

Ground connections in your electrical system are important safety features, which is why codes now require three-prong grounded power cords on tools and appliances, and why wall outlets should be grounded.

Continuation of steps in Project 45:

10. You have now identified wires running to outlet, including bare copper ground wire if your system has one. You will connect wires to new outlet in same manner as they are connected in old one.
11. *If you are replacing three-prong outlet.* You will find short wire connected to ground terminal on outlet and to screw driven into hole in back of box. This is ground connection for third prong. Connect it to new outlet as it was connected to old one.
12. *If you are installing three-prong outlet to replace two-prong outlet.* Cut 5½ in. length of No. 14 wire. Strip insulation from ends and bend wire tips to hook shape. Thread short machine screw into existing hole in back of receptacle box. Insert hook end of short wire under screw and tighten. Now connect this wire to ground terminal of outlet.
13. *To complete wiring of outlet.* Connect black wires to brass terminals, white wires to silver terminals. Connect short wire from screw at back of box to ground terminal on outlet. If you have bare copper ground wire, connect it to same ground terminal on outlet. Tighten all terminal screws.
14. Push outlet into box, using screwdriver to help relocate [illegible] outlet.
15. Reinsert barplate screws, then reinstall faceplate.
16. If system [illegible]
17. [illegible]



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Air Conditioning

The goal of heating experts today is building total comfort into a home heating system. A heating plant and distribution system alone won't do it. You need some heating (and cooling) accessories.

Air conditioning is bigger than heating. The day is coming when your heating system won't be up-to-date unless it cools too. A cooling system may actually be separate from the heating system with a single central refrigeration unit outdoors, and cooling coils inside ducts to create and distribute cool air. The size of the cooling unit must be based on the cooling load of your house, just as the heating system is based on its heating load. Proper design will enable the cooling system to keep the house at 75 degrees and 50 percent relative humidity all summer long. Other temperature-humidity [illegible] if preferred.

The size of capacity of cooling equipment is figured in "tons" or BTU's of heat-removing capacity per hour. One ton of cooling is the amount that would be done by a ton of ice melting in 24 hours. It figures out to about 12,000 BTU's each hour.

Don't get an air conditioning unit that's too far oversized for the load, or it won't run enough to control house humidity. And don't get a unit too far undersized or it won't handle the load on really hot days. An average U.S. home needs from two to four tons of cooling, depending on its size and location.

Cooling capacity figures are listed on the nameplates of modern cooling units.

Air-conditioning systems can be either the through-the-window or through-the-wall kind or centrally ducted. Fuels are usually electricity, but can be gas, too.

Sometimes cooling can be added to a forced-air heating system. Other times ideal cooling requires larger ducts, a more powerful blower and cool air outlets that are placed high on the wall rather than on the floor. Don't sacrifice good cooling by shackling the air conditioner to a heat-distribution system that's not designed for cooling as well as for heating.

Dehumidification

Sometimes removal of moisture from the air makes life more comfortable, even without cooling. Basement rooms in most climates nearly always need dehumidification in summer. If the house isn't air conditioned, moisture-removal is accomplished with a separate unit, usually one on casters that can be rolled where it is needed. If placed over a basement drain, the unit never needs emptying. Otherwise, collected water must be dumped out periodically, unless a unit with an automatic shut-off is obtained.

With a gauge called a humidistat that controls operation of the dehumidifier, you can keep your home's relative humidity at reasonable levels to prevent mildew. Most units have a humidistat built in. If not, a plug-in type can be used. The [illegible] humidistat [illegible] kept closed. No machine can dehumidify the outdoors. One unit, if it has the capacity, will dry all the rooms open to it.

The opposite of removing moisture from the air, humidification, puts water into the air. It's almost always needed during the heating season when heated air tends to be dry.

Humidity - water vapor in the air - is so important in imparting the feeling of warmth that with ample relative humidity, the temperature can be lowered and still be comfortable. Test have shown that most people are comfortable at a combination of 30 percent relative humidity and 75 degrees. For a drop of 30 percent in relative humidity, the room temperature must be raised five degrees to maintain the same body comfort. Such an increase in indoor temperature would show a 10 to 15 percent increase in your fuel bill.

Outside winter air at 20 degrees and 70 percent relative humidity, when heated to 72 degrees inside your house, dries out to only 6 percent relative humidity. This is drier than the Sahara Desert. Humidity should stand at 30 percent, except in very cold weather. There are tight houses where the relative humidity in winter can be raised to 40 percent without condensation problems on walls and windows. At this humidity, a temperature of 70 degrees is comfortable to most people (90 per cent of those tested). This corresponds to the temperature at which most people keep their thermostats.

Some of the needed moisture in a house is put back into the air by breathing, washing, cooking, showering, etc. But

this is often only enough to keep the humidity level at 10 to 15 percent during cold weather. The rest of the moisture must be supplied artificially by a humidifier.

The small plate-type humidifiers that come with many furnaces and mount to the hot air plenum won't add enough water to be worthwhile. They lack evaporative power. You need one of the big, powerful units that literally throw water into the air. As much as 8 to 16 gallons of water a day may be needed. A good unit that can handle this job costs upward of $50. You may save that in doctor bills the first year. Colds and other respiratory infections are greatly reduced by even [illegible]. I've personally experienced this. Didn't believe it when my doctor told me. Static shocks are done away with too.

Minerals in the water are a problem with humidifiers. They build up and eventually affect performance. The best ones are self-cleaning. Lennox [illegible] flushes away mineral deposits automatically.

A humidifier is best when controlled by a humidistat. The humidifier [illegible] the desired humidity, then shut off.

Air conditioning

Determining unit size

Air conditioning systems are of two general types. **Central** conditioning, wh[illegible] entire house, a[illegible] room[illegible]

[illegible]ioning terms: Three terms are basic to making a selection: (1) **BTU**, or British Thermal Unit, [illegible]nage, and (3) **horsepower.**

[illegible] temperature of 1 pound of water 1 degree F. An air conditioner's BTU measurement indicates the amount of heat it will remove.

Tonnage is another means of rating [illegible] used especially in connection with room units. It re[illegible] 1 ton [illegible] achieved by melting a ton of ice in an hour. A useful rule of thumb in relating BTUs and tonnage: An air conditioner will provide 12,000 BTUs of cooling in an hour for every ton at which it is rated.

[illegible] horsepower ratings are still applied to a [illegible]'s it is not considered an accurate method, and it is best to avoid units that are rated this way. The horsepower referred to is that of the compressor [illegible] conditioner, for example, may vary from fewer than 8000 BTUs to well over 10,000.

Determining cooling capacity: Before you consider [illegible] must determine the cooling capacity required by the area that is to be cooled.

One way is to have a competent and reputable dealer come to your home and estimate its needs. He [illegible] the job properly.

If you are considering a central system, get bids from several air conditioning contractors. Be sure each bidder states the number of BTUs per room [illegible] recommends for each separate bids and BTU requirements carefully. Be wary of a bidder whose cost and BTU estimates are too high or too low. The bids won't differ greatly from one another.

You can make a fairly accurate estimate yourself, using the guide given here. But be sure you understand the variables- there are pitfalls for the untrained estimator. Use your estimate only as a guide

FLOOR AREA IN SQUARE FEET

Length

Width	10	12	14	16	18	20	22	24	28
10	100	120	140						
14	140	168							
18									
22	220	264	308	352	396	440	484	528	616
26									
30									
34									
38									

[illegible] BTUs required to cool a particular space you must bear [illegible] your est[illegible] [illegible]mb. [illegible] capacity (12,000 BTUs) for every 400 square feet. The example [illegible] where they [illegible] table at the right [illegible] ...ate feet. Note that up to about 400 [illegible] ...nt beyond that you need [illegible] ...g a [illegible] ...ner. Also, door area affect cooling needs [illegible] ...se windows, exposure [illegible] style [illegible] ...a [illegible]

If your installation will be large and complex it's wise to use the industry form that provides for all these elements and weighs their relative importance.

BTUs	Sq. ft.
[illegible] capac[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
12,000	400
400	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]

Controls for heating and cooling systems

Thermostats and humidistats

If the heart of any heating or cooling system is the [illegible] trols of these systems are appropriately called the brain and nerves.

Room thermostats. The primary control in any heating and cooling system, to the homeowner is the room [illegible] While there are several types, most are based on the principle of differential expansion or contraction of metals when subjected to temperature changes. Different metals, when heated or cooled, expand and contract at different rates. Hence if two different metals are joined into a bimetal strip, this strip, or arm, will bend with temperature changes. This movement is utilized to open or close electrical circuit which turns on the appropriate u[illegible]

The correct placement of a thermostat is most important. This will vary, of course, according to the house plan, but a thermostat should never be placed [illegible] where the surrounding air will be average for the whole house. Never place a thermostat near a fireplace or other source of heat, since this will tend to shut off the conditioning source before the rest of the rooms have reached their desired temperature. Conversely, a hallway that receives gusts of wind every time the front door is opened, is also an unsatisfactory spot for the thermostat.

Multi-stage thermostats: A single-location temperature control for a house is often insufficient, since [illegible] certain to cool some parts of a house more rapidly at some times and less rapidly at others. Such control is bound to lead to constant complaints of "too hot" or "too cold." You can overcome this problem by laying out a zone control of the home's heating and/or cooling system in such a way that a separate thermostat can be provided to control the heat to each area, and the desired temperature maintained in each zone at all times.

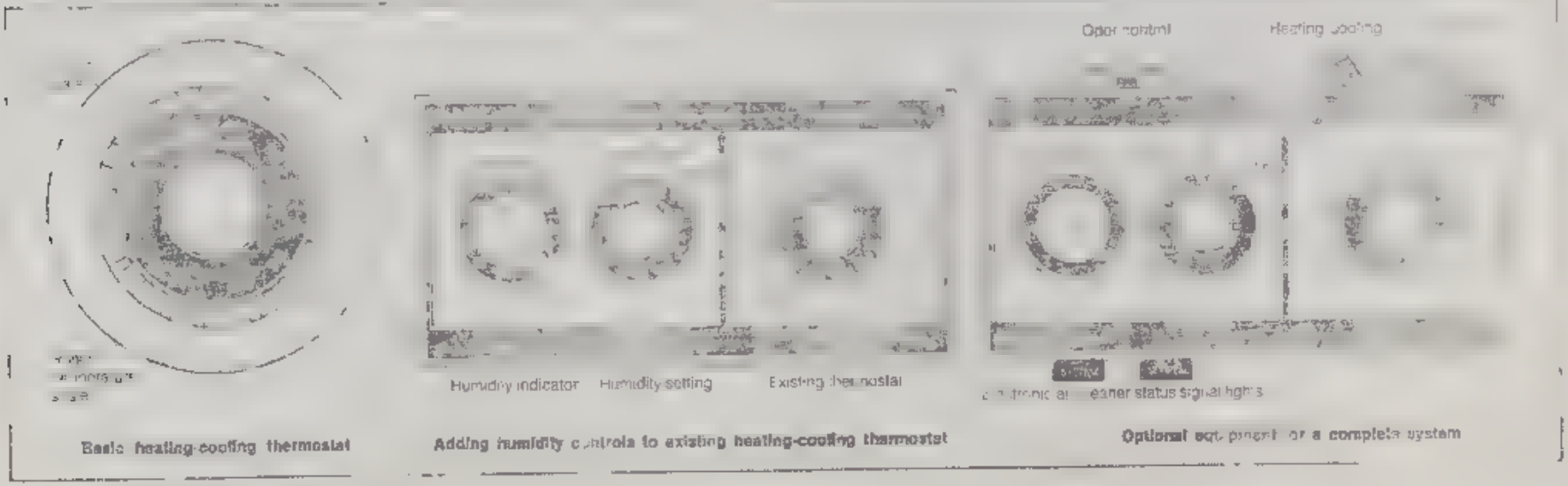
Manual timer thermostats: This model [illegible] is made for people who are away from home much of the day or who have irregular sleeping schedules. A spring-wound timer on the thermostat lets the home owner lower the temperature to cut down on fuel [illegible] time period it automatically returns to the higher comfort setting.

Electric clock thermostat: D[illegible]signed to provide complete care-free control this thermostat requires no attention from the homeowner. On a preset schedule, it automatically [illegible] each day or [illegible] to stay up later than [illegible] light level. The clock is a working timepiece that is an asset on the wall.

Heating-cooling thermostats: Various models are available, among them you can obtain such features as manual or automatic changeover from [illegible] control, two-stage control, and system "off." Automatic day-night [illegible] heating-cooling thermostats.

Humidistats [illegible]. Some control units combine thermostat and humidistat. Such an arrangement permits the control of both the humidity and the temperature. A few home comfort panels even include electronic air-cleaner status signal lights and an odor control. The latter is a device which installed in the ductwork of a forced-air central air conditioning system and neutralizes unpleasant household [illegible]

To add for total home comfort



Basic heating-cooling thermostat

Adding humidity controls to existing heating-cooling thermostat

Optional equipment for a complete system

Function and features of individual units

A room air conditioner's basic function is to provide comfort by cooling, dehumidifying, filtering or cleaning, and circulating air. The units can be placed on a window sill or in a wall. The latter type fits into a built-through-the-wall sleeve. Both vent heated air from the room and condense the outside. Most models also draw outside air through the unit (while filtering and cooling) to the room. Console-type units are also designed to provide heating, by reverse-cycle operation (heat pump), steam or hot water coils, or electric resistance elements.

In the operation of a typical room air conditioner, warm room air passes over the cooling coil, giving up its actual and latent heat. The conditioned air is then circulated by a fan or blower. The heat from the warm room air causes the cold (low-pressure) liquid refrigerant flowing through the coil to vaporize. The vaporized refrigerant then carries the heat to the compressor, which compresses the vapor and increases its temperature to a point higher than that of the outdoor air. In the condenser, the hot (high-pressure) refrigerant vapor liquefies and gives up the heat from the room air to the outdoor air. The high-pressure liquid refrigerant then passes through a restrictor which reduces its pressure and the cold (low-pressure) liquid refrigerant then re-enters the evaporator, and the entire refrigeration cycle is repeated again.

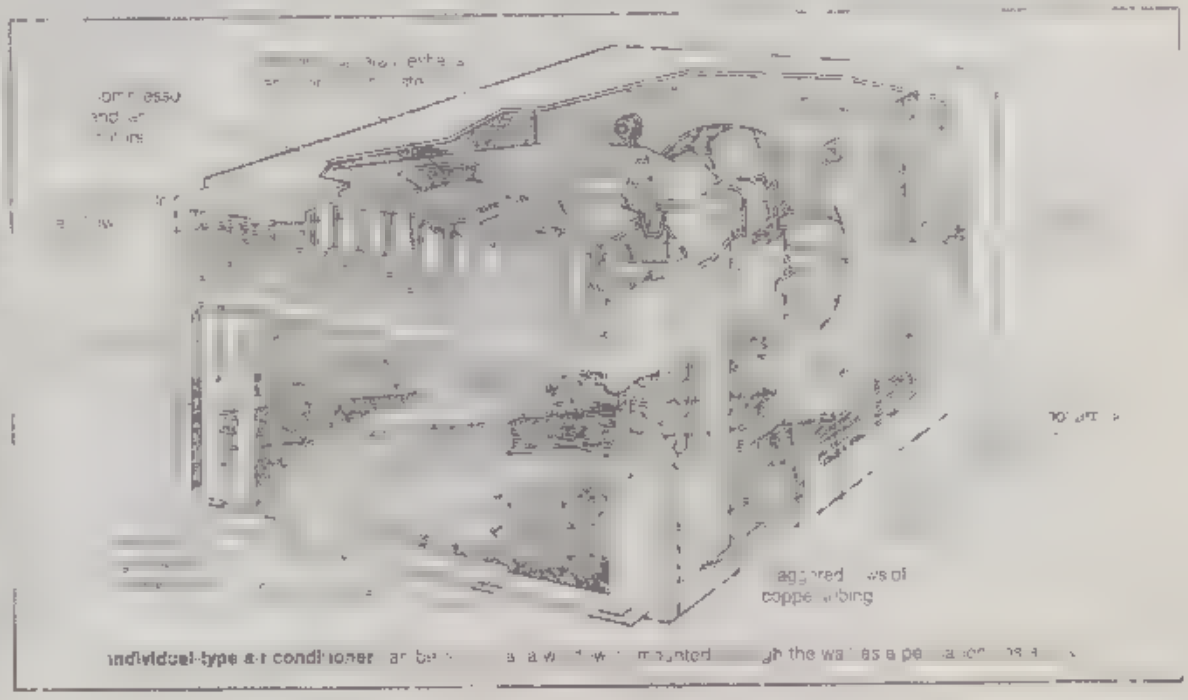
Operation: Room air conditioners are simple to operate. Usually one control operates the unit while a separate thermostat controls temperature. A dial, knobs or levers are provided for [illegible] fan speed. The thermostat may be concealed behind an accessible panel, but it may also, however, be on the top or sides.

Types of room air conditioner. [illegible] type is the slide-out chassis design which permits the outer cabinet to remain in place while the chassis is removed for service.

Features to look for. A thermostat [illegible] fluctuation. Multiple fan speeds to blow the cool air into the room and to circulate it. Most air conditioners have two fan speeds. Economy models may have only one; deluxe models may have more than two. An **automatic control**, which regulates the fan speed to disperse the right amount of cool air to maintain a preset degree of comfort. **Condensation disposal**, which disposes of water removed from the air. **Air direction control**, which regulates the direction of the cool air. [illegible] versions of this control direct the air up to the right and left and straight ahead or in combinations. Other air conditioners actually change the air direction automatically by means of moving louvers [illegible]. **Protection against overload**, a protective device that shuts off the compressor to avoid overheating of the motor windings. **Dehumidification**, the removal of excess moisture from the room air. **Filters**, which remove dust and other [illegible]. These may be metal mesh or plastic (which can be cleaned and reused), or glass fiber (which must be replaced from time to time). **Fresh air intake**, a feature that exhausts stale air or brings in fresh air, or both. This feature makes your air conditioner valuable the year round. It is important to check exactly what type of ventilation any given model provides in terms of stale-air exhaust and fresh-air inlet.

There are other features to look for, such as the sound level of the unit, which is particularly important when an air conditioner is to be installed in a bedroom. A certain [illegible] sound is to be expected because [illegible] the air through the unit and the operation of the compressor. The sound level of well-designed room air conditioners, however, is relatively low and free from excessive vibration and noise.

Room air conditioners require a durable finish, especially on all parts exposed to the weather. Good design calls for baked finishes over rustproof or zinc-coated steels, and the use of such corrosion-resistant materials as plastic, aluminum, and stainless [illegible]. Remember that [illegible] little more. A price cut can be a poor exchange for a reputable brand name and dealer.



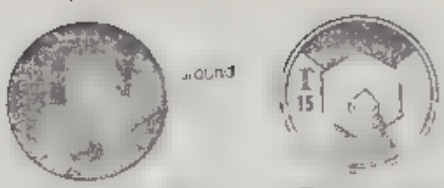
Individual-type air conditioner [illegible] through the wall as a permanent installation.

[illegible] supply

Voltage supply: When the unit is running, the voltage must always remain within plus or minus 10 percent of the rated voltage. Check when compressor is operating.

Grounding: All units are equipped with grounding-type plugs on the service cord. Receptacles used when units are installed should have the correct grounding contact to fit that plug.

Fuses: [illegible] circuit may have in the circuit of the size recommended by the manufacturer. These fuses allow an overload during the starting period



15-amp. 120 volt receptacle — Time delay

Service: Be sure the unit is plugged in and fuses are sound before contacting the dealer. Have the unit cleaned and checked once a year.

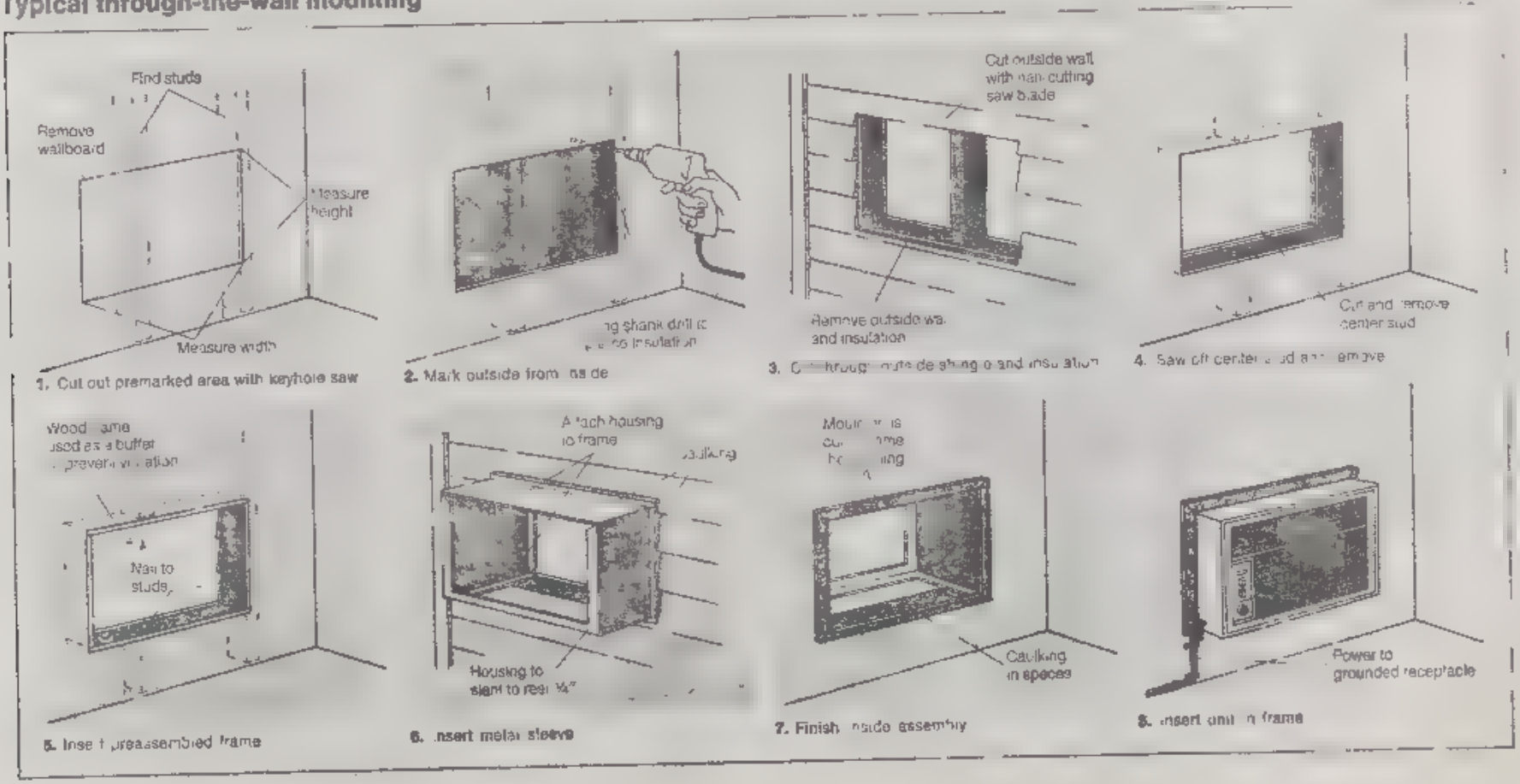
Care and maintenance

Grille: Clean with soft cloth, mild soap, and warm water—no waxes or cleaners [illegible] some contain solvents that [illegible]

Filter: Clean often. Remove as service booklet directs. Vacuum and wash in warm water; shake off excess water; dry and replace filter and grille.

Condensation on grille: Moisture may collect on the grille when the unit is first turned on because of high humidity in the room. If doors and windows in the room are closed, the humidity will be lowered sufficiently to evaporate this moisture.

Typical through-the-wall mounting



Installing room units

Mounting methods

Many lightweight, smaller-capacity, through-the-window air conditioners come with a do-it-yourself installation kit, which provides all the parts for proper mounting. Gaskets, panels, and weather-tight seals. Instructions and procedures make installation easy for you and a helper, but should be followed carefully to ensure satisfactory results.

Installation of larger-capacity models generally calls for experts. Let your dealer handle the job to be sure it is done properly and the unit is working efficiently. Through-the-wall and some large window units have a permanent sleeve. Small air conditioners can be removed and stored over the winter.

Installation procedures and hardware for room units can be mounted several ways. It is therefore important to consider what mounting is most suitable to existing conditions and local building codes. Common mounting methods are:

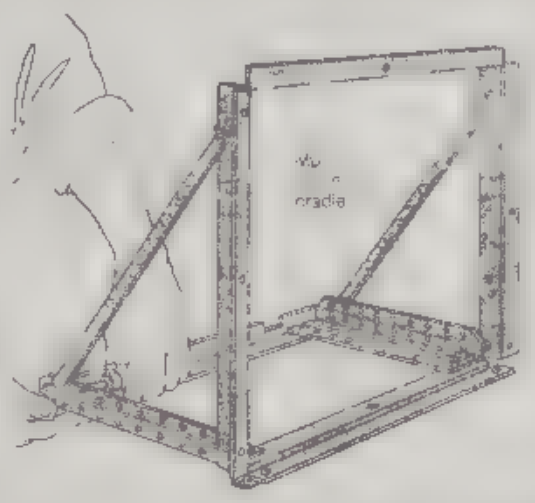
1. **Outside flush mounting:** Outer face of unit is flush or slightly beyond outside wall.
2. **Inside flush mounting:** Interior face of conditioner is approximately flush with inside wall.
3. **Balance mounting:** Unit is installed approximately half inside and half outside the window.
4. **Interior mounting.** Unit is completely inside the room, permitting the window to be closed.
5. **Upper sash mounting:** Unit is mounted in the top of the window.
6. **Special mounting:** Unit designed for casement windows and horizontal sliding windows.

Through-the-wall mounting sleeves are used to install window-type chassis, complete units, or consoles in walls. Units with hot water or steam coils are usually permanently wired with armored cable or conduit. Generally a plug-in wiring arrangement is provided to facilitate working on the cooling portion without disturbing the heating system.

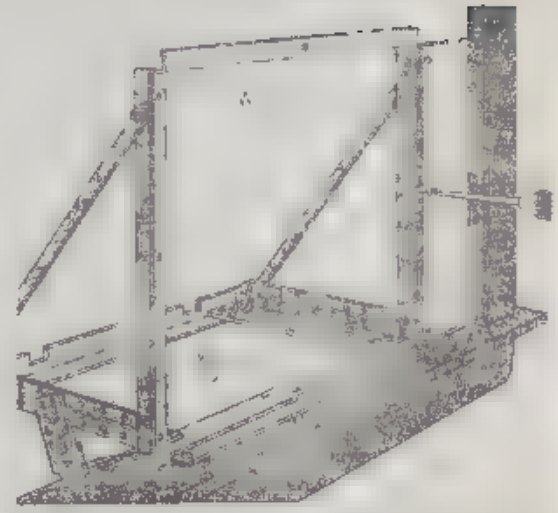
Location of unit: Install a room conditioner as far as possible from exterior doors to prevent drafts and cross-ventilation from interfering with the cooled air. Make sure there are no obstructions in front of the unit such as chairs or draperies. Direct the vents upward so you get cool air at the upper levels (it will drift naturally down to the floor).

Exterior doors and windows in the room should be completely weatherstripped. If too much outside air comes in through cracks, the unit will have to work harder to remove heat and humidity.

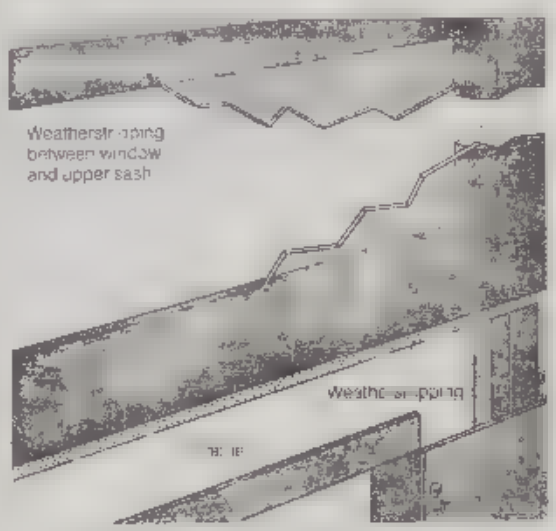
Typical double-hung window mounting



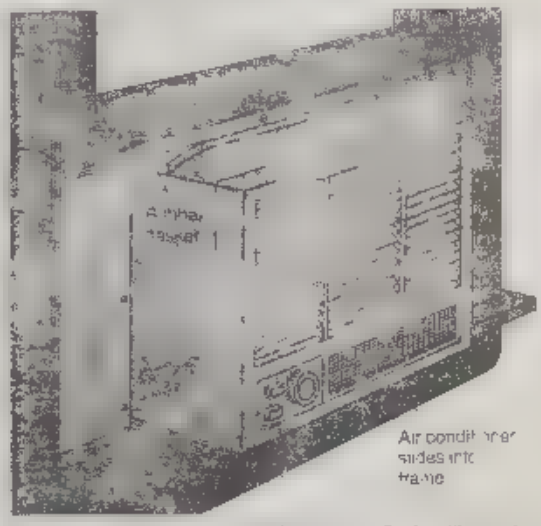
1. To install a room air conditioner, first assemble the mounting frame or cradle that comes with the unit. Frame is designed to bear the weight of the unit.



2. Mounting frame is centered in the window. Small leg screws to sill near edge. A slight pitch to sill sets water drain outward.



3. Sash is weatherstripped full width and lowered to top of frame. Additional weatherstripping is installed against upper sash of lower window to shut out all drafts.



4. Air conditioner slides into frame until flush with window. A heavy rubber gasket tucks in place and air seals the space between frame and unit.

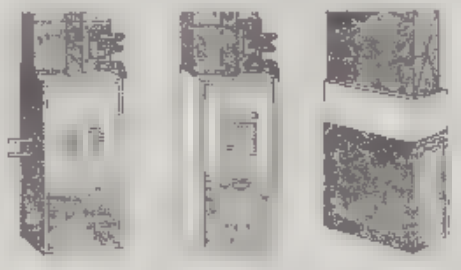
Central air conditioning

Installation

Central air conditioning, as explained previously, means whole-house conditioning, 24 hours a day the year round. It is designed to distribute conditioned air through a series of ducts already in existence or installed for the purpose.

Lower operating cost, better overall cooling efficiency, and quieter operation are the major advantages of central systems. In most installations, it is proportionately less expensive to centrally air condition an entire home than to get the same amount of cooling from individual units. Central systems can, however, be more expensive to purchase and install than room units if no usable ductwork is available. Ripping open walls and ceilings, when this is necessary, can be quite costly. On the other hand, in a one-story house with open attic or basement, ductwork can be easily and economically installed.

The heating for a year-round central comfort system that is to work in conjunction with an air conditioning system may be oil- or gas-fired, or all electric. Complete central units, which are quite small compared to earlier models, can be installed virtually anywhere in the home—in basement, crawl space, or attic, in a central hallway, closet, garage, etc.



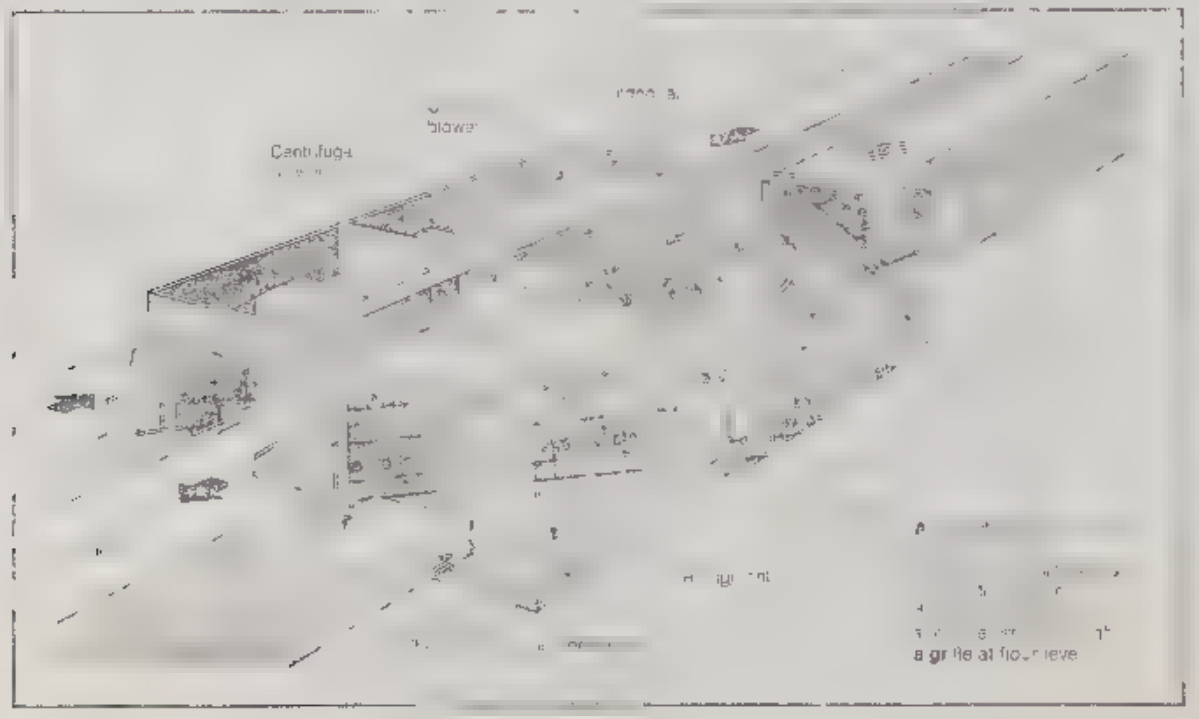
Oil-fired Gas-fired All-electric

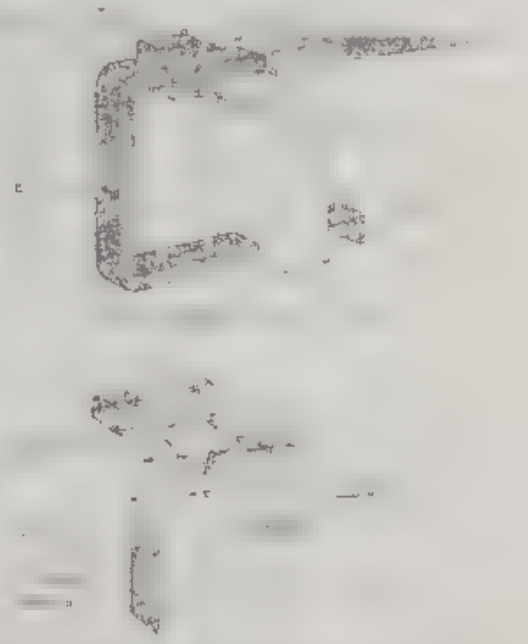
Single-package unit

There are two types of central air conditioning: the single-package unit and the split system. The package unit is [illegible] the same compartment or adjacent ones. It is the least expensive system, but the noise of the compressor makes an outside location preferable. In the split system, the components are separated—the cooling coil inside the house and the condenser and compressor outside—so that all the noise and vibration are kept out of the house.

When the single-package unit is used in conjunction with a heating system, it is coupled to the furnace and uses the furnace's ductwork. When it is used independently, as a cooling-only unit, arrangements must be made to duct air to and from the work area. For an outdoor installation of this type of unit, it is necessary to run a connecting duct from air conditioner to ductwork.

Independent unit for cooling only





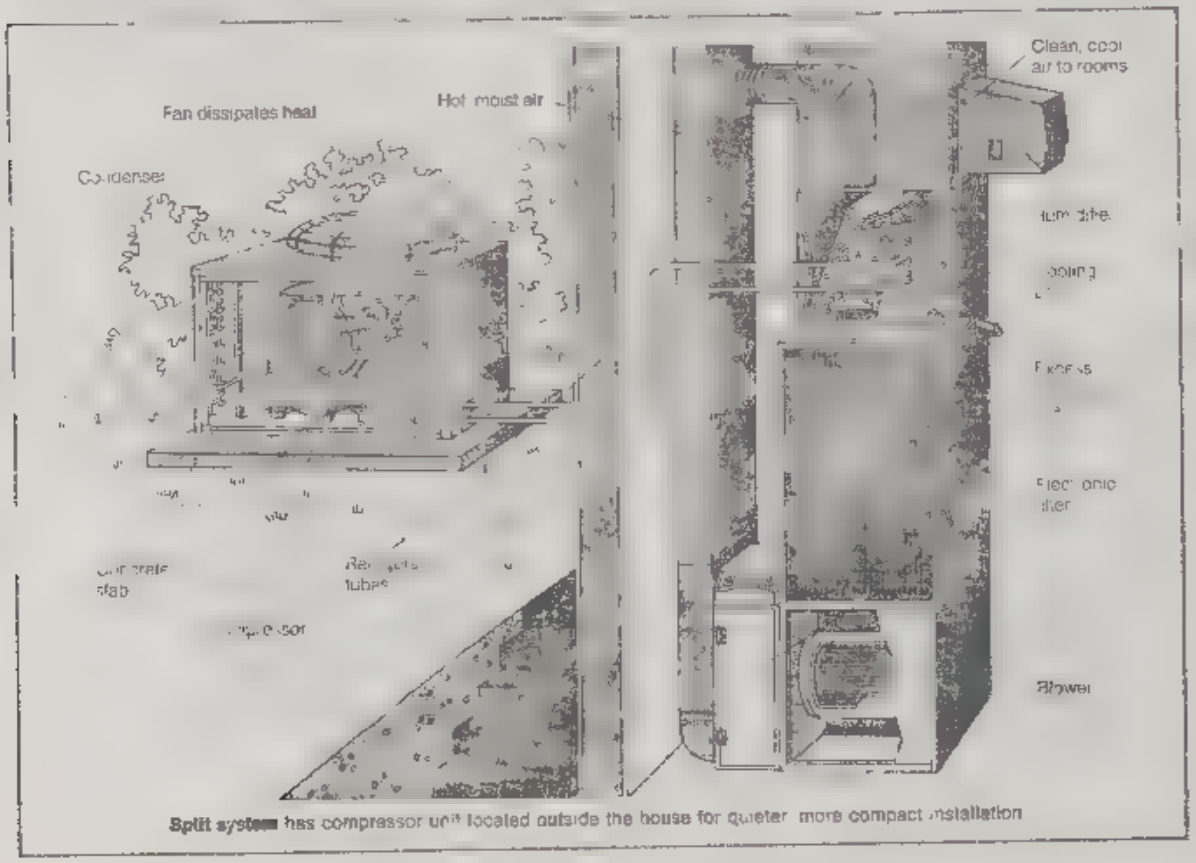
Furnace with blower coil and closed return

Split system

This [illegible] of air conditioner is suitable for every kind of home and heating system. The condensing unit is located outdoors at the most convenient place [illegible] connected by small-diameter copper tubing to the evaporator cooling coil located at the furnace, using the furnace blower and ducts for summer cool-air distribution. The vertical air-flow evaporator, or cooling coil, is installed on top of the air discharge outlet of an upflow type forced air furnace. The evaporator for the horizontal type A horizontal evaporator can be installed at the [illegible] discharge outlet of a horizontal furnace [illegible] crawl space. A downflow evaporator is placed underneath a downflow furnace and is commonly used in slab construction and basementless houses or in houses which are built above a crawl space.

For homes with non-ducted heating systems, a special blower is used. It may have its own duct system for discharge cool air directly into [illegible] through [illegible] grilles. These independent units are ideal for installation in central hallways, attics, or closets. They often offer an optional electric heat module for winter [illegible] operation.

Although slightly more expensive than a single-package unit, the split system's specifications automatically eliminate interior noise and the need for large holes through an exterior wall (necessary to accommodate the connecting duct in a single package outside installation). Split systems are the dominant choice for installation in new and existing homes.



Split system has compressor unit located outside the house for quieter, more compact installation.

INSTALLATION CHECKLIST

1. In most units, heat is dissipated from the condenser by a stream of air directed over the coils by a fan. Other models require special cold water connections and a drain or water evaporator "tower" outside. In these devices cold water in a jacket around the coils [illegible] evaporated by compressed refrigerating gases. Check local ordinances [illegible] the excessive water use and loss involved.

2. Ductwork passing through areas that are not air conditioned should be insulated to prevent condensate problems and heat gain. Also [illegible] ductwork [illegible] be used for cold air, check the size. Warm and [illegible] travel in ducts smaller than those required for cold air. Ducts should be insulated.

3. Some air conditioners require 230 volts to operate the motor. This generally necessitates a special [illegible] the fuse box. A separate line should always be run from the fuse box to the air conditioner regardless of the [illegible] voltage requirements. This prevents the overloading of other household circuits.

4. The condensing unit should be located, if possible, where it will receive a minimum of direct sunlight. There should be at least [illegible] between the condenser [illegible] and any walls or obstructions which might [illegible] restrict [illegible] to the [illegible]. The air space should be at least 12 inches [illegible].

5. [illegible] wiring and refrigerant [illegible] installed so they are protected against being walked on or accidentally damaged in any way.

6. The [illegible] coil can be used [illegible] furnace blower [illegible] as well as heat [illegible] the blower compartment [illegible] with its own blower and [illegible] the main duct of the heating system. A damper [illegible] which is designed [illegible] during the [illegible] when the heating system is [illegible].

7. Be sure that your proposed [illegible] satisfies [illegible] building codes and FHA requirements.

8. Check whether draining of evaporator condensate could present any problem.

9. Care should be taken in locating and mounting the condensing unit so that the operating vibration (though slight) are not exaggerated by the building construction or by the mounting mechanism.

10. If the unit is to be installed in the furnace, the cooling coil should be placed downstream. If it is placed otherwise, cold air will collide with warm air flowing into the furnace from the flue before the cold air reaches the duct work. The coil sweating will cause insulation to warm inside the furnace with consequent loss and corrosion in the unit. When the cold air is downstream, the cooling coil section is usually butted against the furnace's heat exchanger. With this arrangement, the cold air passes directly into the exchanger and duct work, bypassing any warm air that is in the furnace.

Solving the problem of too little moisture

Physicists define relative humidity as the ratio of the amount of water vapor that air contains to the total amount of water it could contain at a given temperature. This is always stated as a percentage.

When the air around us is chilled, it becomes drier, because the capacity of air to hold moisture decreases as the temperature drops. We feel cooler or warmer in proportion to the rate of evaporation of moisture from our bodies. The temperature and moisture content of the air, and the moisture evaporation rate, are important and related factors in comfort control. In winter, heating makes air extremely dry, producing rapid evaporation of body moisture. To keep comfortably warm, we must maintain an air temperature between 75 and 80 degrees. If we add moisture to the air, we can be comfortable at lower temperatures, as low as 70 degrees. For comfort and health in wintertime, relative humidity should be between 30 and 50 percent. You can buy a humidity guide which will indicate, by means of a pointer, the percentage of moisture in the air.

The best way to maintain a proper home humidity level is with a power humidifier. Such a unit helps to correct the condition of extreme dryness that can cause not only personal discomfort, but damage to furniture and other household furnishings as well. An automatic humidistat permits selection of the desired humidity level, after which the humidifier takes over, automatically maintaining that level.

Types of humidifiers: Power humidifiers work on two basic principles. Evaporator types capitalize on the fact that warm air moving over water can pick up moisture by simple evaporation. Atomizer types mechanically break up water into fine particles which the surrounding air can readily absorb.

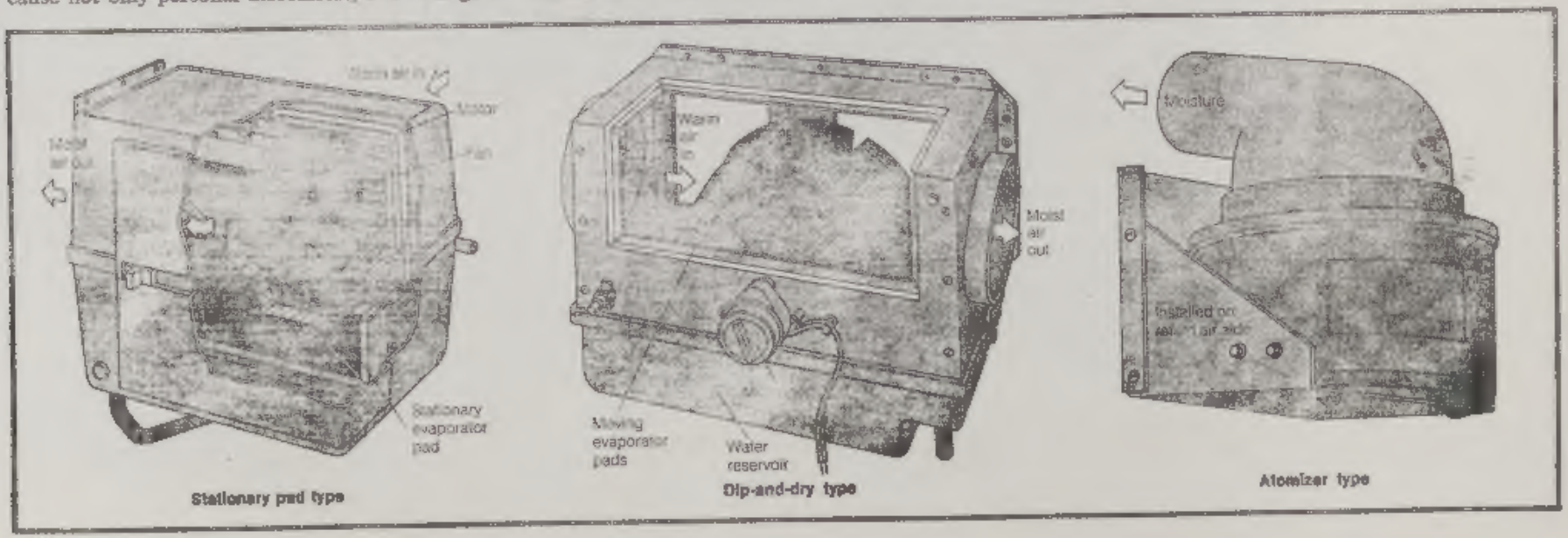
There are several powered evaporative types on the market. One is the **stationary pad type** in which a motor and fan assembly draws the warm air from the supply duct, passes it through the evaporator pad, and returns humidified air back into the supply duct. This provides a constant, positive stream of humidified air into the supply duct and the living area any time the warm air furnace is in operation.

Another type might be called a **dip-and-dry** design. It relies on motor power to dip evaporative media into the water; then exposes the wetted surface to the moving warm air.

While primarily designed for homes with forced warm air, powered evaporative units can also be designed with a blower and used in homes equipped with other heating systems. Evaporation is accomplished by means of hot water, rather than heated air. The humidified air is circulated through a duct to a centrally located grille.

Operating on a completely different principle—mechanical break-up of water into particles which the surrounding air absorbs—the **atomizer** type is independent of the movement of warm air, and when installed in ductwork, is located in the cold-air return. Some models can also be installed in a closet, over a cabinet, almost anywhere that water and electrical connections are available. All that need show is a small opening with free access to the house air. If you provide reasonably good air movement between rooms, it is possible to humidify all of them from this one point, since water vapor tends to spread evenly. Both atomizer and evaporative types are also available in portable form.

It should be pointed out that many warm-air furnaces are equipped with an evaporative-plate humidifier. These units, however, rarely have adequate capacity, and because they work on capillary action, they are subject to clogging from mineral deposits. A powered unit is the only sure way to supply a home with a proper and consistent humidification level.



Dehumidification

How dehumidifiers lower the humidity level

At some seasons, even a tightly constructed home can have problems of undesirably high humidity. These may be attributable to a combination of factors, such as frequent showers, wet towels, drying clothes, cooking, floor washing, or ground moisture. Two common methods of reducing the humidity are: 1) mechanical dehumidifiers; 2) attic fans to replace warm, moist air with cool, dry outside air.

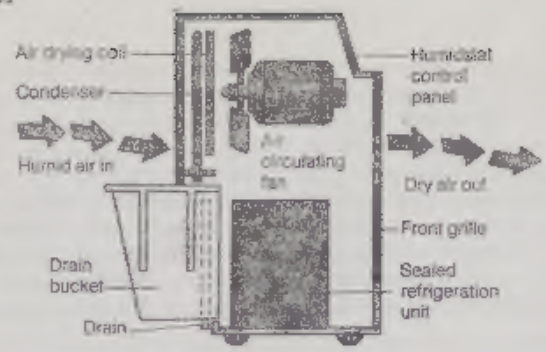
Mechanical dehumidifiers consist of a refrigerated surface (often called the air-drying coil), a condenser, an air-circulating fan, a humidistat, and a cabinet to house these components.

How a dehumidifier works: Moisture-laden air is drawn over the refrigerated coils by the fan. As the damp air hits the cold surface, the moisture condenses and drips off into the collection bucket, or is carried off to a drain by a hose connected to a drip tray. Most dehumidifiers have a hose connection designed to fit a standard garden hose. Get one long enough to reach the nearest basement drain. Or set the dehumidifier over a sink or washtub.

Continuous recirculation of room air in this way gradually reduces the relative humidity. The addition of a humidistat control to the system will automatically help maintain a preselected relative humidity. Controls are normally supplied in an adjustable range of 30 to 80 percent relative humidity and can hold the circulating air to within plus or minus 3 percent of the selected humidity.

Capacity and performance ratings: A powered dehumidifier is rated according to the pints of water it will remove in a 24-hour period from air that is at 60 percent relative humidity and 80 degrees temperature. Most home power dehumidifiers have from 10- to 30-pint capacity. Performance is generally evaluated in terms of pints of condensate per kilowatt hours. In a one-room basement, one unit should suffice. Or, depending upon air movement in your home, you may need one for each main living area.

The refrigerated, or air-drying, surface may take the form of bare-tube or finned-tube coils in vertical or horizontal tube arrangements. Exposed vertical tubes tend to collect smaller drops of water, encourage quicker run-off and less re-evaporation than horizontal tubes. Because header connections of closely spaced multiple-vertical tubes involve high construction costs, spiral evaporator tubes can be a good compromise. These coils are often staggered for maximum exposure to the flow of damp air. In any unit, be sure that the coils are held firmly in position to provide good drainage and to eliminate the possibility of rattles or vibration.



How a dehumidifier works

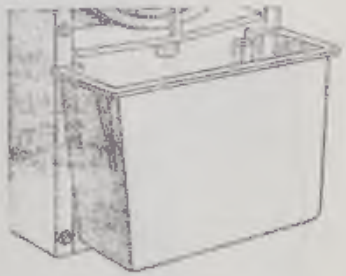
Operation of dehumidifier: Dehumidifiers are used winter and summer in some parts of the country. Regardless of season, they work best with doors and windows closed. Remember that the rate of moisture discharge will vary with the weather. Generally, the hotter the day, the faster the flow of water.

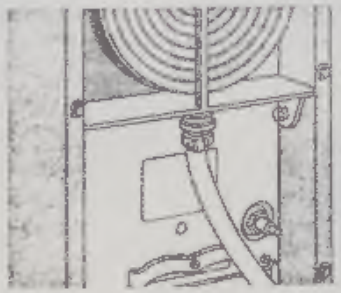
The only maintenance a unit usually requires is removal of dust and dirt from the refrigeration coils, the condenser, and the fan units. Most other problems should be left to an experienced serviceman.

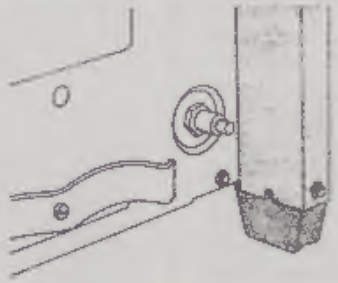
Features to look for


Adjustable humidistat: Humidity control starts the dehumidifier and automatically cycles on and off as required to maintain selected humidity conditions.


Exposed air-drying coils: For easy cleaning and top efficiency at low operating cost, the air-drying coils are frequently staggered and left exposed.


Catch bucket: When used, the water catch bucket should hold at least 10 qts. and should be so arranged that it can be easily removed and emptied without spilling.


Threaded hose connection: A connector for a standard garden hose should be available for direct and continuous removal into the nearest floor drain.


Automatic water overflow control: To prevent overflow of bucket, many models have an automatic shutoff switch. A signal lamp lights up when the bucket is full.


Recessed wheels: For complete mobility and greater stability, recessed wheels plus easy-roll casters should be provided. Usually two recessed wheels are sufficient.

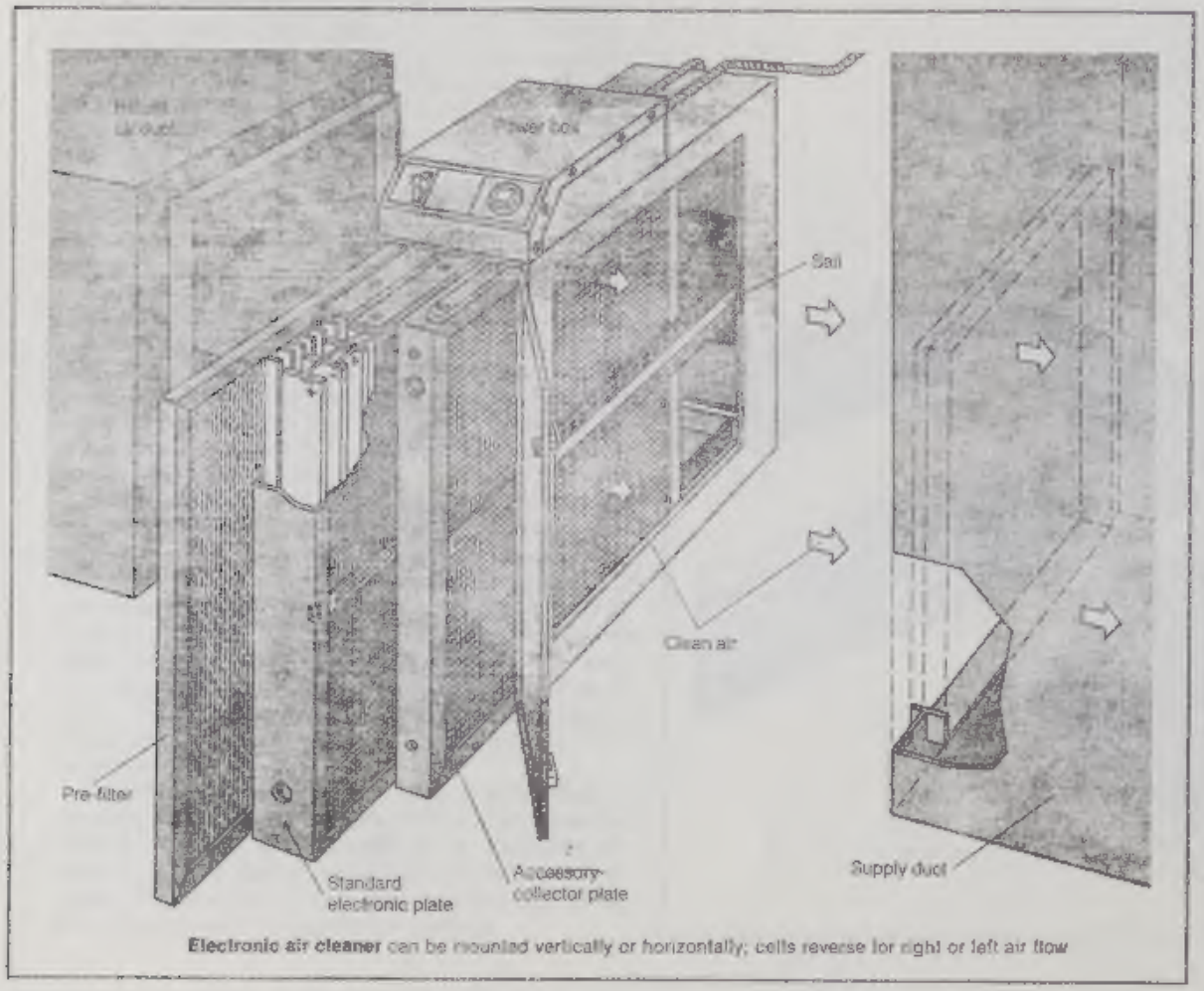
Electronic air cleaners

Types, operation, maintenance

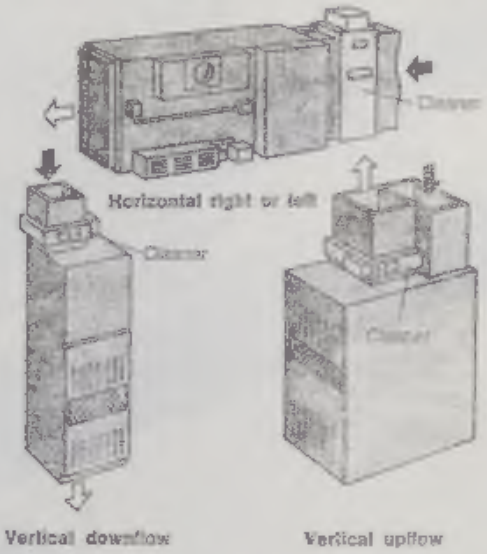
Electronic air cleaners electrically remove not only dust particles from the air but smoke and pollen as well. They are available in self-contained units for room use and in central systems which are attached to a warm-air heating plant. Since most air cleaners are guaranteed to remove up to 95 percent of the particulates in the air (the standard warm-air furnace filter is capable of removing only up to about 10 percent), they make house cleaning easier and less frequent, keep air more healthful to breathe, and give relief to sufferers from hay fever and other allergies.

How they work: "Electrostatic precipitation" is the scientific name for the process by which the air cleaner traps airborne particles. When these particles are carried into the cleaner unit, they pass through a powerful electrical field and receive an intense positive electrical charge. When they reach the collecting section, the particles enter a second electrical field set up between a series of metal plates or screens. In a way similar to a magnet's attraction of iron filings, the positively charged particles are hurled against the negative collecting plates, where they stay until they are washed off. The process is continuous. As the air is recirculated through living areas and back into the air cleaner, it is recleaned to remove new dirt particles that enter from outside or are stirred up indoors.

Self-contained models. These are easily movable, and are designed for use wherever you wish air to be cleaned. All of them employ a built-in motor-driven fan to circulate air through the unit. The self-contained types are ideally suited for selective air cleaning, or for applications where installation of a central system unit is impractical.



Electronic air cleaner can be mounted vertically or horizontally; cells reverse for right or left air flow



Central system models. These units are designed for permanent mounting in the ductwork of a central system—forced warm-air, air conditioning, or heat-pump. Air flow through the electronic cleaner is provided by the system's circulating fan.

Maintenance: About the only maintenance required is occasional cleaning of the collector plates. You simply remove the slide-out plates and wash them. Some models feature a wash-in-place unit which permits plates to be washed without removal. A few units even have a light bulb arrangement to indicate when plate cleaning is necessary.

Attic fans

Though an attic fan does not reduce temperature, the air movement it causes helps to cool the body by evaporating perspiration, creating more than just an illusion of comfort. Furthermore, the fan will ultimately reduce temperature and humidity as it replaces hot indoor air with cooler night air drawn in from outdoors. By adjusting doors and windows according to needs and conditions, the fresh, moving air can be routed through any part of the house.

Types: Attic fans are of two basic types. One is placed in an opening cut in the gable end; the rest of the attic is then sealed except for a louver through the ceiling to the area below. Indoor air moves into the attic as the fan pulls the attic air out. The other type of fan is placed in the ceiling beneath the attic and pulls air directly from the living area into the unused space above. The attic air then moves outdoors through ventilating louvers, usually in the gable ends. Louvers must always be large enough for the volume of air the fan can move to pass freely.

Size: Fans are made in a variety of sizes. Blade size and speed determine how many cubic feet of air the fan can move per minute. To determine the appropriate size (take all of the dimensions in feet), multiply house length by house width by room height by the number of floors of living space. (Do not consider the basement as a floor in making your calculations.) From the result, deduct 10 percent (for closet space and other areas the fan will not have to ventilate). The final figure is the number of cubic feet of air that the fan must move.

In the South, the fan should be able to handle the total volume once a minute; in the North, two-thirds of that amount. For example, take an average two-story-plus-basement house in Georgia 35 feet long, 22 feet wide, and with 8-foot ceilings. Multiply 35 by 22 by 8 by 2 (stories) and you get 12,320 cubic feet; deduct 10 percent and the figure is 11,088—the cubic feet of air per minute the fan should be able to move. If the house was in New Hampshire, the fan would need only two-thirds of that capacity, or 7392 cubic feet.

Mounting the fan: The type, size, and method of operation govern construction details. A fan mounted directly over the grille should be on vibration absorbers, usually rubber, or on felt padding, to deaden noise and vibration. A fan mounted directly before the louver is best suspended on springs.

Typical truss construction installation

